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Determining Factors of the Czech Foreign Trade Balance: Structural Issues in Trade Creation

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Abstract

Using panel data for 29 industries, we test alternative specifications of Czech export and import functions. The balance of trade is primarily influenced by the real exchange rate, aggregate demand and tariff changes. Reduced growth of the Czech economy after 1996 was an important factor that has kept the balance of trade at a sustainable level in the medium-term, contributing even to the appreciation of the real exchange rate. The secondary fundamental factors, relevant for structural adjustments, a sustainable trade balance and an equilibrium exchange rate, rest, however, on supply-side characteristics such as changes in endowments of physical and human capital, inflows of FDI and growing competitiveness of domestic production. We can argue that appreciation of the real exchange rate is a handicap to Czech exports, especially to exports to non-EU countries. Nevertheless, in the EU case, the appreciation of koruna was countervailed by tariff concessions, improved quality, switchover to commodities with higher contents of value added, gains associated with FDI and growing foreign demand absorption. At the same time, appreciation of the real exchange rate has significantly opened the Czech market to imports but the unconstrained import penetration remained blocked by the growing competitiveness of Czech products in costs, prices and quality.

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Nontechnical Summary

The basic objective of this paper is to design an appropriate structural model based on economic behavioural foundations and test it on data representing the determining factors of Czech trade specialisation and growth. Policy recommendations based on the functioning of some policy instruments relevant to monetary policy decisions are also a part of the study.

In the empirical part of the analysis, we use alternative specifications of export and import functions estimated as panels for the EU and non-EU countries, disaggregated into 29 industries for 1993–2001. According to our results, the main drivers of the Czech trade dynamics are associated with changes in the relevant aggregate demand (GDP) and the real exchange rate. Reduced growth of the Czech economy after 1996 is an important factor that keeps the balance of trade at a sustainable level in the medium-term, contributing even to the appreciation of the real exchange rate.

In addition, there were present further strategic factors influencing the trade structure and dynamics: changes in endowments of physical and human capital, inflows of FDI, developments in productivity and wages, enterprise pricing policies and the nature of Czech economic competitiveness *vis-à-vis* the world markets. This includes the switching from competition in prices to competition in quality, and the rising role of differentiated products and intra-industry trade.

Appreciation of the real exchange rate is clearly a handicap to Czech exports, especially to exports to non-EU countries. Nevertheless, in the EU case, the appreciation was countervailed by tariff concessions, improved quality, switchover to commodities with higher contents of value added, gains associated with FDI and growing foreign demand absorption.

At the same time, appreciation of the real exchange rate has significantly opened the Czech market to imports but the unconstrained import penetration was blocked in the recent past by the growing competitiveness of Czech products (competing in costs, prices and quality). The threat of widening trade balance disequilibrium was neutralised also by rising export prices while their physical volumes stagnated.

We can induce from our analysis that the fundamental restructuring of Czech enterprises is driven by openness to trade, especially with the EU. There are also the positive effects of lifted tariffs, accelerating inflows of FDI and exceptionally fast changeover in Czech exports towards products with higher unit prices. While exports and FDI inflows offer growth and employment, accelerating import penetration requires the downsizing of many industries, which burdens the whole Czech economy with high adjustment costs. Now, in a period of economic structural stabilisation and EU accession, the prospects for accelerated economic growth are much higher.

The dynamics of Czech exports and imports remain, however, "locked-in" within certain structural constraints that can be changed only gradually. This "lock-in" is the legacy of specialisation in products at a low level of value added (i.e., in products with low per-kilogram prices) and of competition based on both price concessions and massive inputs of labour with low wage requirements.

1. Introduction

The policy of any national bank has two domains: the state of inflation and the state of the exchange rate. From them, however, there are both forward and backward linkages with the economy relating to growth, employment and external equilibrium. The causes and effects influencing the national bank's policy "domains" cannot be studied by concentrating on macroeconomic aggregates alone when the country is subject to a profound restructuring that is microeconomic in essence, concerning enterprises, industrial product specialisation, quality changes and competitiveness.

Macroeconomic aggregates can give a false picture of real changes if there are perfect trade-offs between enterprises (or industries) in the sense that the expansion of some of them is countervailed by the demise of others. The estimation of the factors behind structural changes, especially in the manufacturing sector, is therefore an issue highly relevant to monetary policy-making.

The exchange rate is an economic parameter that is closely related both to the sustainability of the current account balance and to the direction of net flows on the capital account. Many economists make the mistake of relying on macroeconomic analysis alone when talking about exchange rate regime options, nominal convergence and the trade balance. In the transition economies, the exchange rate level is neither just a function of relative price level changes (between countries or between the traded and non-traded sectors) nor an outcome of changes in average productivities of labour.[1]

The dynamics of the real exchange rate sustainability in transition countries are related to cycles of qualitative change, which need not be uniform throughout the economy. For example, there may be gains in output growth in one particular industry due to export expansion and gains in the terms of trade caused by product and marketing quality upgrades. The economic shock preceding that event may at the same time be perfectly balanced by a contraction of other, less efficient export industries. Although there are no apparent changes in the trade balance, the new structure of exports and imports has moved to a higher level of competitiveness that can be sustained by an appreciated exchange rate.

Macroeconomic analysis of the real exchange rate – taking into account aggregate changes only – has limited scope for explaining the depth of such underlying factors.

Our applied study offers an alternative, microeconomic approach by concentrating on the dynamics of the export and import components of GDP. These fields are dominated by three theories of specialisation: Ricardian, neo-classical (Heckscher–Ohlin) and the "new theory". Unfortunately, at this first stage of the research we could not cover all parts of the theories.

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[1] For example, in the most recent study in that train of pure macroeconomic thought, Egert (2002) could explain only 5–20% of the real appreciation in countries such as Poland, Hungary, the Czech Republic and Slovakia by the Balassa-Samuelson effect. Unfortunately, the standard macroeconomic models used for such purposes are too simplified compared with the excessive structural non-stationarity of transition economies, so that their results may give a distorted picture of reality.

As regards policy predictions concerning the trade balance or exchange rate effects, there are three assumptions for attaining a high degree of reliability: (1) the coefficients of past trends are estimated in an unbiased way; (2) the explanatory factors represent the true economic fundamentals; and (3) these fundamentals (by their nature) are not excessively volatile.

2. Trade, Growth, Competitiveness and Modelling

The problem addressed in this paper centres on growth and on the evolution of the competitiveness of domestic production vis-à-vis competition with producers from abroad. A large part of such change is reflected in exchange rate pressures. The opening up of the post-communist economies and the process of their integration into the European Union (EU) had a big positive impact on the structure of specialisation and on growth throughout Europe – see Pelkmans (2002). However, the need to divert trade from the East to the West and to restructure supply had high costs, too.

On the part of the transition countries, there were large terms-of-trade and transformation losses. The competitiveness of their domestic economies initially decreased sharply, something that was reflected in real exchange rate depreciation and profound decreases in unit labour costs. After stabilisation and economic recovery the real exchange rate began to appreciate, wages rose and exports increased exponentially, reflecting gains in competitiveness – see Campos and Coricelli (2002).

In all the transition economies, the highest rates of trade growth were achieved in trade with the EU. For example, during 1993–2001, Czech exports to the EU rose from EUR 6.3 billion to EUR 25.6 billion. This fourfold increase implied average annual growth in exports to the EU of a remarkable 17.6%, while Czech exports to the rest of the world grew at a normal nominal rate of 4% (including inflation).

At the same time, the trade creation with OECD partners was accompanied by a large trade diversion from the former partners grouped in the Council for Mutual Economic Assistance (COMECON). Trade liberalisation concessions on the Czech and EU sides have therefore opened an unprecedented window of opportunity. Their particular structural development was country specific – determined by particular local characteristics such as factor endowments, policies and other economic factors.

The liberalisation of trade had major repercussions on the transition countries' domestic economies by offering new strategic incentives for growth and restructuring. This automatic impact of the openness was often so strong that it dominated the economic growth. For example, the fast development of Czech international trade throughout the 1990s was one of the crucial constructive factors of transition across the Czech economy. It is the purpose of this study to deal more closely with the theoretical, quantitative and technical aspects of the analysis of such changes.

Taken theoretically, the developments in international trade in small open economies determine the allocation and efficacy of the majority of domestic resources. Since their share of traded

commodities produced for exports and domestic import replacements in GDP is very high, the export and import functions overlap to a large extent with the empirical models proposed for the explanation of GDP dynamics, for example in Barro (1991), Levine and Renelt (1992), Sala-i-Martin (1996), Crespo-Cuaresma et al. (2002), and Badinger and Tondl (2002).

The overlap can be explained using the macro identities for production (Y) and absorption (A), where the indices *D* and *M* indicate the "domestic" and "imported" origin of domestic consumption:

$$Y = (C_D + I_D + G_D) + (C_M + I_M + G_M) + X - M \tag{1}$$

and, after the subtraction of imports:

$$Y = C_D + I_D + G_D + X \tag{2}$$

$$A = C_D + I_D + G_D + M \tag{3}$$

The export and import functions are relevant for explaining not only exports and imports (X, M), but also for that part of domestic production for domestic consumption ($C_D + I_D + G_D$) that is traded. This means that some determining factors for X and M can be also potentially relevant for the allocation of resources to those domestically produced and domestically consumed commodities where there are either alternatives to export, or where the imports compete with domestic production.

In the Czech case this implies a relevance not only for the 65% of GDP that is exported (or imported), but also potentially for that part of ($C_D + I_D + G_D$) that is traded internationally – estimated at an additional 15–20% of GDP. Thus the location, redistribution and demise of resources for the production of at least 80% of the Czech GDP may be subject to the evolution of comparative advantages and competitive advantages estimated by the export or import functions.

The general relevance of export and import functions for growth in transition economies and their crowding-out of the standard macromodels of growth can be strengthened by technical arguments for the estimation of the parameters of growth.[2] While the estimation of macroeconomic production functions depends on time series, which are usually too short and hide the depth of adjustment processes in the economy, the estimation of the export and import functions can benefit from the additional information contained in their sectoral dimension.

Moreover, the export and import functions are (pragmatically) superior to closed economy growth models because they can deal more naturally with the interaction of the domestic economy with the outside world. The intrinsically asymmetric evolution of sectors lies at the core of the growth dynamics. This has little meaning in closed economies, where the factors determining the output structure are completely exogenous to the economy.

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[2] Aggregate production functions estimated using macroeconomic identities have been subjected to harsh criticism recently. The best overview is provided by Felipe and McCombie (2002).

Although "competitiveness" is a word very often used by business leaders and government officials, it is seldom to be found in economic textbooks [3], which prefer the term "comparative advantage" – a narrowly defined formula for describing the causes of producers' success or failure on world markets. However, as one gets through to the substance of comparative advantage, as explained by either the Ricardian or the Heckscher–Ohlin theories, it is not difficult to understand that "comparative advantage" and "competitiveness" need not necessarily overlap, because competitiveness is a much wider and more heterogeneous concept.

In the Ricardian sense, "comparative advantage" means a favourable starting position in the physical labour content (intensities, requirements) of a physical unit of production of one producer relative to the labour content of the production of its competitors. In the Heckscher–Ohlin context, it is the ability of firms to adjust the structure of production to the relative factor endowments of that particular country. Here, "comparative advantage" and "competitiveness" can be taken for synonyms.

On the other hand, the term "competitiveness" as defined in the business literature has a strictly pragmatic meaning: as the capacity of firms to sustain their market share, or even as their ability to increase their market share. Market structure changes are often in the background of competitiveness in this sense. Hardly anything is said in such literature about relative labour content or about factor requirements matching endowments, even though implicitly they may be important.

Competitiveness can be also achieved by taking advantage of economies of scale, product differentiation, consumer taste and market power.[4] Here, the argument may still remain within the tenets of the new trade theories, though its causes have shifted far away from the classical theories of comparative advantage.

As a crucial alternative, competitiveness can be explained by institutional and policy factors, such as the use (or abuse) of public resources in the hands of the government and by various protectionist measures – see Bayard and Elliott (1992). There, the most notorious case is the subsidisation of agricultural products in the EU. This may lead to EU agriculture turning from goods out-competed by imports to "successful" export commodities – see Pelkmans (1997, pp. 168–171). The rising social costs of such gains in competitiveness are often disregarded.

Higher competitiveness in international trading can be also achieved by exchange rate depreciation or by directly lowering wage rates. The theories behind various definitions of real exchange rates are important theoretical contributions to the explanation of "competitiveness". In

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[3] Paul Krugman made a very sharp critique of this fashionable term. According to him, "competitiveness" may be interpreted as "a poetic way of saying productivity, without actually implying that international competition has anything to do with it"– see Krugman (1994, p. 33). On the other hand, economists from business circles argue that "It is widely accepted in the economic literature that a country's competitiveness cannot be reduced only to GDP and productivity, because firms must cope with the political, cultural, and educational dimensions of countries, as well as their economies" (WCY, 2001). So "competitiveness" is not a concept related to the nation as a whole (as Krugman imputes), but it may still remain valid at the level of enterprises.

[4] The literature most often referred to in this respect is Helpman and Krugman (1985). A textbook description is given in Krugman and Obstfeld (1997). Coming to terms with these factors is a crucial condition for growth in all modern open economies.

its less orthodox version, appreciation of the real exchange rate, defined as higher growth in the price level of non-traded goods over growth in the price level of traded goods (well structured in line with comparative advantage), could become a serious threat undermining the competitiveness of internationally traded production in a large segment of the economy.

Furthermore, imbalances on the domestic monetary side have links to problems on the external side of the real economy, as was first analysed by Salter (1959). Various monetary policy instruments can therefore influence competitiveness beyond the objectively determined comparative advantages – see Dornbusch (1973). Although the traditional theory of the real exchange rate can tell us a lot about competitiveness in stabilised economies, it can offer only a small part of the story in cases of transition economies, as the paper by Egert (2002) has shown.

Theoretical terms like comparative advantages, factor endowments and factor productivities are treated as objectively given national economic fundamentals that directly influence competitiveness in trade on international markets. However, "competitiveness" can be significantly influenced by subjective factors, among which economic policies are the most important. Different policies can have different real outcomes, thus influencing the development of fundamentals. The effects of policies can have a polar direction: they can either enhance the role of fundamentals (e.g., improved education promoting efficiency) or turn against them (e.g., by subsidising inefficient firms).

We can therefore judge policies in open economies either as instruments for the support of market pressures, global growth and competitiveness – calling them policies of encouragement and discipline – or as instruments of discouragement and protection that decrease competitiveness in the long run – see Selowsky and Mitra (2001). Therefore, competitiveness is a term describing empirical phenomena related both to fundamental determining factors and to policies.

Observed empirically, competitiveness in foreign trade is therefore revealed as differences in the growth rate that lead to a change in the composition of exports or imports over time, which can be related to two structural aspects: the geographical (territorial) breakdown and the commodity breakdown. Our problem can be depicted by a matrix of trade growth indices π_{ijt}, taken separately for annual changes in exports ($_\Delta X$) and imports ($_\Delta M$):

$$\pi_{ijt}^{(X)} = \Delta X_{ijt} / X_{ijt-1} \tag{4}$$

$$\pi_{ijt}^{(M)} = \Delta M_{ijt} / M_{ijt-1} \tag{5}$$

where i = 1, 2, 3, …, *m* are the trading partners of the analysed "home" country;

j = 1, 2, 3, …, *n* are the commodities traded;   and

t = 1, 2, 3, …, T are years.

The empirical estimation of the whole problem can be simplified by taking natural logarithms of the trade flows X_{ijt} and M_{ijt} and all relevant explanatory variables. However, the dynamics of "why and where we are headed" can have a meaning only if we understand "where we are now", which requires the study of those factors that actually determined the present structural dimension of X_{ijt} and M_{ijt}.

The methodological roots of this approach are present in the principles of economic policy modelling – see Tinbergen (1952) where present, future and past are intertwined in the following predictive model: $X_{ijt+1} = \varphi (X_{ijt-1}, \Delta X_{ijt})$, where the structure of past X_{ijt-1} and the dynamics of present ΔX_{ijt} need not be subject to identical determining forces. For example, the former could have developed in the environment of central planning and early stages of transition, while the present and the future evolve in a globalised market environment.

Therefore the dynamic analysis open to the future (X_{ijt+1}) must be supplemented by a static (structural) analysis of the past (X_{ijt-1}), reflecting the fact that the past of transition economies was moulded by different factors than the current changes (ΔX_{ijt}). At the same time the current "flows" (ΔX_{ijt}) are not completely independent of the particular state of accumulated "stocks" embedded in X_{ijt-1}.

The aim of this study is thus two-pronged: to find out what determining factors were behind these changes in trade flows in the past and what forces are driving them into the future. The analysis will be based on econometric hypothesis testing using export and import functions applied to Czech data. The policy implications and predictions for the process of EU enlargement are also among the aims of this paper.

3. Structural Trade Changes and Restructuring in the Process of Opening Up

The international trade among Communist countries under the institutional backing of COMECON was relatively intensive. However, it lacked the support of a market mechanism for determining the structure of specialisation at the level of standard economic agents such as producers, exporters and importers. The structural microeconomic problem of specialisation was therefore determined at the level of bureaucratic decision-making – to a large extent outside of enterprises and without market signals.

It was thus highly probable that the resultant specialisation pattern would miss some of the absolutely crucial economic criteria, such as comparative advantages, efficiency and competitiveness. The result is thus obvious: the allocation of resources would be sub-optimal and, in the long run, the problems with external balance and GDP growth would intensify.

Until the end of the 1980s, the trading situation among the COMECON countries looked quite satisfactory, at least at the level of macro statistics. The volume of trade was growing and the external imbalances were always accommodated by some sort of administrative intervention. In all cases the trade of the COMECON countries revealed signs of preferential trading characteristics, so typical for countries with economies integrated under a formal (institutionally controlled) treaty. In other words, they revealed features of trading where preferential treatment in international exchange was guaranteed for the member states only. Little attempt was made to hide the fact that the decision-making was grossly discretionary (administrative) and that discrimination was an obvious rule.

Most surprisingly, however, the commodity breakdown of trade among the COMECON partners revealed characteristics compatible with the Heckscher–Ohlin criteria. This means that in the

majority of cases, the trade structure was compatible with endowments and scarcities in the basic productive factors (labour, capital, human capital and natural resources) – see Benacek (1988a), (1988b), and (1989).

Once the COMECON institutions collapsed and price and trade liberalisation became a standard policy among its former member states, intensive trade diversion was the natural process that followed as an aftermath. As early as 1991, negotiations began on the preferential trading arrangements offered by the European Commission to some of the post-communist countries. The Association Agreements of these economies with the EU countries, aimed at creating a free trade area, were concluded during 1992–1994.

The trend of channelling the majority of trade through free trade arrangements led to the creation of the Central European Free Trade Agreement (CEFTA) in 1993. Its impact was visible in intensive trade creation among its members, often at the expense of trade diversion from countries outside the EU and the CEFTA alliances. In that sense CEFTA behaved like a typical customs union – see Pelkmans (1997).

Our empirical analysis will concentrate on comparing the developments in Czech trade with two geographical regions: (1) the European Union (*EU-15*, accounting for 68.9% of exports and 61.8% of imports in 2001); and (2) the rest of the world (*RW*), consisting of the remaining developed market economies (6.2% of exports and 9.7% of imports), the European post-communist countries (21.2% *X* and 19.9% *M*), and newly industrialised countries and less developed countries (3.7% *X* and 8.5% *M*).

Although Czech trade with the EU is dominant and steadily growing, the regional trade balances will remain open to large changes due to the expected EU accession and fluctuations in the enormous capital account surpluses with market economies. Trade re-adjustments due to trade diversion and the diversified intensity of trade creation with alternative trading partners associated with restructuring of enterprises will long remain a sensitive issue in all transition economies.

The balance of trade can be brought to equilibrium by various mechanisms and policies, and we should be aware of which factors are behind the dynamics of exports and imports.

4. Data and Bias in the Statistics

Our main aim – the quantification of factors related to the intensity of trade flows – depends to a large extent on the quality of the data. Although both the international and Czech trade statistics appear to be highly elaborated, there are many methodological problems. Extensive data overhauling and conversion must be performed before the model computations can be undertaken.

First, Czech exports to the EU need not be the same as the EU's imports from the Czech Republic. Significant differences in the national customs statistics can arise from the different commercial statuses of the trade – the former is in parity of FOB (free on board), whereas the latter is measured as CIF (cost, insurance and freight), where the difference is caused by transportation

and insurance costs between the Czech border and the reporting country. Different timing of customs declarations can be also a source of variations in the international annual statistics.

We should also consider the potential for errors or omissions, the latter being sometimes intentional due to tax evasion. The statistics on the quantities of trade (e.g., in tonnes) are especially prone to errors, since not all commodities are declared in the same metric units. Some data can be in a different nomenclature system. For example, trade is usually recorded in the Standard Industrial Trade Classification (SITC) codes or the Combined Nomenclature (CN) classifications describing products, while the statistics of production and supply-side characteristics are in the Statistical Classification of Economic Activities (such as NACE or OKEČ) describing productive processes.

The researcher has no better option than to transform one system of statistics into another, which may become a cause of bias. After considering the alternatives we finally decided to base our analysis on the conversion from SITC (4-digit nomenclature) into NACE (2 digits). Building a reliable automatic conversion routine was more difficult than we expected – becoming one of the main elements of this paper.

There were two further problems. International trade may be recorded in different currency units (US dollars or euros) than the remaining domestic statistics. The average exchange rate can bias the conversion into Czech koruna (CZK), since the exchange rates may fluctuate daily and the given variable of sectoral trade need not develop linearly over time.

Last but not least, methodological changes in statistical reporting can lead to serious bias in trade time series. For example, the post-communist countries adopted the World Trade Organization's (WTO) statistical standards without retrospectively adjusting their time series. Thus the items (i.e., re-export, inward/outward processing and leasing) added to the Czech trade figures since 1995 can seriously compromise the compatibility of the time series starting in 1993. Therefore, it is highly advisable to devote sufficient time and statistical techniques to data checking and adjustments for evident errors and omissions.

Figures 1 and 2 depict how the shares of Czech imports and exports changed over the period 1989–2001 with respect to six major regions. We can see that trade with the EU countries had the fastest positive dynamics. The share of trade with CEFTA and with developing countries declined only marginally, while Russia and Ukraine were the main losers. We can also observe that the bulk of the changes occurred during 1990–1994.[5]

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[5] A similar structural change is revealed in the Hungarian trade structure – see Darvas and Sass (2001). In a more detailed examination we can see that it was Germany that became the main winner in the long-term battle for the Czech market. German-speaking advanced markets (Germany, Austria and Switzerland) make up more than half of the Czech trade turnover. In 1971 the figure was just below 10%.

Figure 1: Share of Czech imports from economic regions in 1989–2000
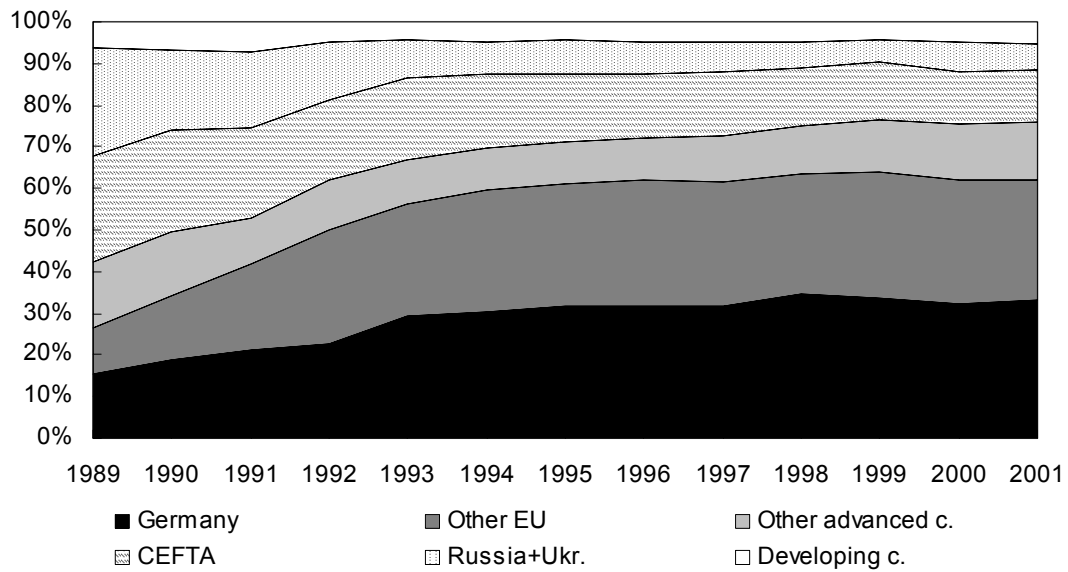
Source: *Czech Statistical Office trade statistics adjusted for changes in methodology.*

Figure 2: Share of Czech exports to economic regions in 1989–2000
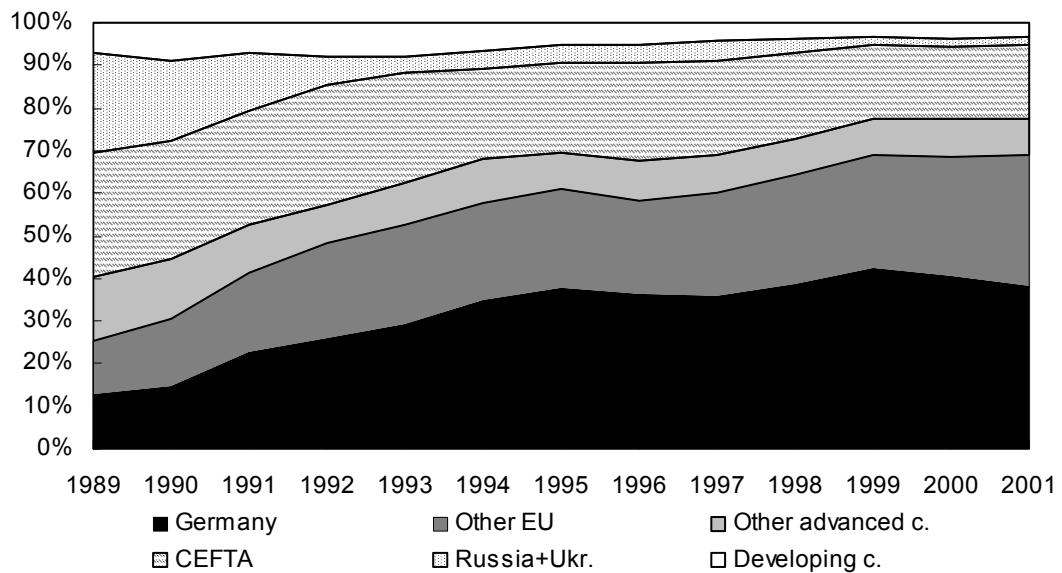
Source: *ibid.*

The period 1995–2000 is characterised by geographical stabilisation, while the growth rates of trade remained very high (over 15% annually). In parallel, there were profound changes in the industrial structure of trade.[6] This is an important factor for our analysis, since our studied period of 1993–2001 is composed of two parts: 1993–1994, when trade diversion prevailed, and 1995–2001, when trade creation was dominant.

There is an inconsistency problem when we work with time series in an environment that is subject to intensive systemic (qualitative) change, such as an economic transition. *A priori* we cannot exclude the case that during the studied period the nature of economic agents (especially firms) changed to such a degree that the underlying trade was subject to different behavioural patterns. An artificial amalgamation of disparate time periods and disparate groups of industries (or enterprises within industries) could then result in a weak statistical significance of the estimated behavioural characteristics.

Mixing two or more populations of data into one dataset for testing, each of which responds differently to the explanatory variables, can be dangerous. This problem can intensify if the data are composed of industries of two types: (1) those developing under the pressure of FDI and international competition; and (2) those resisting the restructuring (e.g., in the expectation of a bailout from the government or other implicit subsidies). Special statistical methods have been developed in order to reveal such situations. One of them is known as robust statistics – see Visek (1996). For more information about its application to the problems of international trade, see Benacek and Visek (1999). From this aspect, this study has not yet been concluded.

A serious methodological problem is associated with the statistics measuring physical capital – a crucial variable for the Heckscher–Ohlin theory of trade. There are only two official time series in constant prices. The first one, for 1993–1997, is in adjusted purchasing prices without depreciation. The question is what might be the real price of inactive assets in so many still surviving (but heavily indebted) enterprises with ever decreasing output. The alternative time series is only for 1994–2000, where the assets are at replacement cost (market value) adjusted for depreciation. The transformation of the latter to the former (which we used for 1998–2000) is to a large extent a rough approach. Also missing are OECD statistics of physical capital, which could be used for estimating relative capital endowments (e.g., Czech endowment of capital per unit of labour relative to the EU).

5. Specification of Models for Empirical Testing of Imports and Exports

Our basic import and export models for the empirical testing are derived from the theory of international economics. Unfortunately, there is not just one theory of trade and specialisation. Econometric studies dealing with the estimation of factors influencing the commodity structure of international trade have had to tackle this problem by combining a number of exogenous variables

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[6] The best studies in this respect are by Tomsik, Kubicek and Srholec (2002a) and (2002b). According to them, the structural changes (at NACE 2-digit classification) were present in all transition economies, though Hungary had the most extensive restructuring. Nevertheless, the intensity of structural changes is a microeconomic phenomenon and only a more disaggregated level of industries (e.g., at 3 or 4 digits) can unveil the real intensity of the new specialisation patterns.

that do not come from just one theoretical school of trade specialisation – see Pain and Wakelin (1997), or Aturupane, Djankov and Hoekman (1997). Luckily, the parallel paradigms seem to concentrate on alternative aspects of the causal forces leading to trade.

5.1 GDP, Exchange Rate, Prices and Quality

For imports, we test which factors are active in determining the value of imported commodities in industries disaggregated into the two-digit NACE classification $i = 1, 2, …, 29$ during the nine years $t = 1993$ through 2001, as expressed in nominal values (in CZK). In accordance with Keynesian theory, the current values of Czech imports (M_{it}) are considered to be a function of Czech gross domestic product (GDP_t) in real terms (constant 1995 CZK) and the variable of industrial price changes (PC_{it}). The combination of these two variables reflects the potential purchasing absorption of aggregate domestic demand in nominal terms.

The coefficient of the variable of price changes has an additional interpretation: if it is statistically significant and negative, then (under the assumption of one market price) we can treat it as a standard demand factor. An autonomous price increase in an industry discourages its consumers from purchasing the given product, irrespective of its origin. If the sign is positive, then we should look more at the supply side: the products are either improving in quality or the industry is subject to evolving oligopolistic pricing. In that case it is also a measure of "nominal convergence" in given industries.

In addition, we must extend this set of explanatory variables by adding the real exchange rate (RER_t based on the CPI), since the individual industry-based inflators are not correlated with real exchange rate changes that are universal for the whole economy. Real exchange rate appreciation (i.e., higher values of the RER) should be associated with globally rising imports.

On the other hand, exports are tested as a function of GDP in the partner countries (in nominal EUR) and the real exchange rate, which transfers aggregate demand abroad into the part of Czech effective aggregate demand related to potential exports. In addition, we could retain here the variable of Czech price changes in industries. It is assumed that the differences in the indices of sectoral price changes reflect a narrowing of the gap between world prices and the former prices under central planning. If this parameter is positive it is a measure of nominal convergence related to the intensity of trading.

The sectoral price change index reflects how domestic relative prices change after the economy is opened up to the West. We might expect that in sectors open to trade, the nominal (price) convergence will proceed faster until all domestic prices of tradables are equal to the prices abroad. This is also closely related to improvements in the terms of trade, which "pass through" from exports into a higher domestic price level. The higher the rate of "imported inflation" is in the given industry, the higher the growth in its exports should be. The Stolper–Samuelson and Haberler theorems are consistent with this hypothesis. They explain why export sectors record higher "inflation" than sectors without comparative advantages. We should thus expect a positive coefficient for this variable.

Let us now continue with the specification of our functions. In accordance with the classical theory of trade, imports are considered to be a function of relative unit prices based on costs; namely, we should relate domestic and foreign unit prices. But this raises a question about specifically which prices should be compared. One option is to take internal prices at home relative to internal prices abroad, as is done in the literature describing the evolution of trade from autarchy. Such statistics unfortunately do not exist. Alternatively, we could compare domestic export prices with the export prices of our foreign competitors. This is again a problem, since we have too many competitors all over the world and we are not sure which of them are the relevant ones.

Last but not least, because we are dealing with tradable commodities in highly open and competing economies, we could compare domestic export prices with the prices of domestic imports, which was the option finally selected for this study. It is assumed that these two prices represent competing products. A similar option was taken, for example, in the seminal papers by MacDougall (1951), (1952).

If the model is non-linear (e.g., a power function of Cobb-Douglas type),[7] then its coefficient represents the "elasticity of substitution" of world consumers (importers) of the given product between our country's exports and the production of our competitors. A review of the problem is provided in Harberger (1957). Here, we are challenged by methodological problems concerning both the numerator and the denominator:

a)   Since neither the unit prices for the aggregated NACE groups of products nor even the time series of their inflators are available, analysts are obliged to resort to substitutes. In our case we use the values of exports and imports (in CZK) per tonne of the given products as proxy variables for unit prices. This is obviously a second-best option that has only pragmatic justification.

b)   Unit prices based on values per tonne can have an ambiguous interpretation, since they reflect both the cost (i.e., the price competitiveness of two otherwise identical products) and the quality. In the latter case, if the prices differ, the products are differentiated. In the case of vertical differentiation the products only appear to be similar, because they belong to "vertically" different consumer baskets due to their different levels of quality (e.g., up-market and down-market products). According to various studies, vertical differentiation dominates the trade among industrial countries – see Fontagné *et al.* (1998). If our indicator of relative prices changes over time, we may interpret that in two ways: first, we may assume that there is a "vertical" shift in relative quality and not in relative costs. The reason for that may be that the law of one world price allows only such price differentials. But the law of one price has its clear limits. Thus we may make a second assumption where competition is based only on changed prices without any recourse to shifts in quality. Both of these important alternative aspects should be estimated in our empirical analysis.

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[7] Taken specifically, we could "explain" the intensity of Czech exports to the EU using the model:

$X_{it}^{EU} = A \ (PX_{it}^{(EU)} / PM_{it}^{(EU)})^B$, where A is the constant term and B is the coefficient of the elasticity of substitution between purchases of an identical commodity i produced both in the Czech Republic and in the EU. PX and PM are the price indices of Czech exports to the EU and Czech imports from the EU, respectively.

c)   The problem of relative price competitiveness can be even better revealed if the differentiation is horizontal. In such a case, the products belong to a similar quality category but may be different in both their prices and in their costs.

The problems mentioned under b) and c) are associated with representation. The measurement of comparative advantage, in the strictest sense of the Ricardian theory, is subject to two different price comparisons – see Brenton *et al.* (1997, pp. 15, 23): (1) the relative prices of two identical products from two countries (before trade starts); and (2) the terms of trade of two different products from two countries (when trade exists and when the law of one price is valid).

In the first case, we compare identical products from two countries, where the relationship PX_{it}/PM_{it} can be applied only for autarchy, since the opening-up of trade equalises the prices of identical products and the product with local comparative disadvantage is not traded by that country.

In our estimated models, the condition of export product homogeneity and its perfect substitutability by imports is therefore infringed, because in each of our 29 NACE product groups we compare two bundles (vectors) of products subject to an unpredictable degree of variety. Thus we can limit ourselves to the second case of the above two relative price comparisons. Although such relative prices have hardly any meaning in the given year, we can at least interpret their changes over time, because our relative price index actually becomes an index of the terms of trade – and that is a concept that definitely has its economic relevance.

In other words, in the variable PX_{it}/PM_{it} the commodity index i becomes fuzzy – it says nothing about the product-bundle homogeneity. Thus we are located in a space of uncertain variety: defined from an index of price competitiveness between two perfectly homogenous products (competing in prices under horizontal differentiation), up to an index of classical terms of trade derived from barter between two completely different (and mutually non-competing) products. Although these concepts have a different theoretical interpretation, their changes over time still retain important information about competitiveness in both price and quality.

All three of our caveats a), b) and c) are serious. We know that in the indices *PX/PM* we are measuring two features of competitiveness (i.e., price and quality competition) that run in parallel, and we are not certain if they complement or clash with each other. We offer some logical clues for getting out of the tangle by accepting some simplifications that have a high degree of credibility. We once again repeat that it is not the absolute values in the price variables that matter in our regressions, but their annual changes over nine years. For example, in the model of Czech exports to the EU we test the price variable PX_{it}/PM_{it}. After taking natural logarithms, we can separate them and get $ln(PX_{it})$ and $ln(PM_{it})$ and simplify the matter to a problem of rates of change.

Table 1: Relationship between unit prices (P), quality (Q) and export intensities

Case	Characteristics	Export intensity	Sign of coefficient	Implication	Type of competition
1a	P↑	↓	minus	Q↑ less proportional	in prices
1b	P↓	↑	minus	Q↓ less proportional	in prices
2a	P↑	↑	plus	Q↑ more proportional	in quality
2b	P↓	↓	plus	Q↑ more proportional	in quality
3a	P↑ (& Q↓)	↓	minus	paradox	in prices (Q ignored)
3b	P↓ (& Q↑)	↑	minus	paradox	in prices (Q ignored)
4a	P↑ (& Q↓)	↑	plus	absurd case	false inference about Q compet.
4b	P↓ (& Q↑)	↓	plus	absurd case	false inference about Q compet.

If the sign of the export variable is statistically significant and negative, then export price decreases over time are compatible with more intensive exports. The case that higher exports would be compatible with decreases in export quality can be refuted as logically incorrect. Therefore, we can judge that it must have been the price (cost) competitiveness in Czech exports that was the dominant feature of their penetration on the EU markets. A review of the problem is given in Table 1, where this case is described in rows 1a and 1b.

On the other hand, if the coefficient has a positive sign for *PX*, that would indicate the dominance of Czech quality competition (see cases 2a and 2b in Table 1). Higher exports are compatible only with improvements in quality, which are reflected in price increases.[8] The complication is if at the same time the coefficient of PM (representing foreign products competing with ours) is also significant and positive. Then we can say that, with high probability, the Czech "average" export growth happened in spite of the EU's rising quality. Thus both competitions in quality were successful, thanks, for example, to well-chosen differentiation of products.

Problems may arise, however, in some of the paradox situations illustrated in the last four rows of Table 1. In case 3a, a price increase is implicitly associated with a quality decrease, which naturally leads to a loss of exports. Though our inference on price competition is correct, we fail to recognise the parallel existence of competition in quality. In cases 4a and 4b, we even may come to false conclusions in which we ascribe the gains in exports to improved quality, while in reality the quality decreased. Even though we would fail in cases 3a through 4b (partially or fully), we can assume that the probability of such cases must be extremely low, and thus the impact of their bias can be disregarded.

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[8] There are two strategies for achieving this. First, the quality of all existing products could be increased (on average). Second, the quality of products may remain virtually unchanged but we export more from those vertically differentiated commodity groups that have higher per – kilogram prices – that is, where value added is higher, which is interpreted as products of higher quality.

Additional information can potentially be derived from the determination of trade intensities by unit prices PX and PM acting jointly. For example, exports X_{ijt} can be determined in a way that both coefficients are positive but their statistical significance differs, such as in a case where the significance of *PM* is very high, while the significance of *PX* is at just the 5% level. First, we should be aware that the degree of significance reflects the strength of prevailing global tendencies valid both in space (29 industries) and over time (9 years). In this case, the Czech export quality competition is still a dominant feature for export gains, but at the same time there must exist some less successful Czech industries that lose their exports because they are not able to offset the evident rising quality competition in EU domestic products with their own quality improvements.

We can infer logically from these facts that the only short-term survival strategy for firms unable to adjust in quality would be to lower their export prices.[9] The resultant nature of the competition is then mixed: the dominating competition in quality is partially outweighed by competition in prices. As an addition to our analysis, we could separate by robust methods of estimation those industries that are competing in prices from those competing in quality. Or we could pool the industries and estimate only the losing subset – in this particular case the coefficient for *PX* should then be negative.

Another problem to discuss is when both price variables are statistically insignificant. In such a case, we would end up in a grey area, with both price and quality competition seeming to be irrelevant in their global impact on trading. This is logically untenable (provided the per-tonne prices were changing over time), because the competition should have one or the other form. It is not very credible that the elasticity of demand to price or quality changes would be zero.

We conclude either (1) that our price data are wrongly measured and therefore they were not correlated with the real factors of competitiveness, or (2) that our data consist of two mutually perfectly balanced mixed populations of products that, in their relationship to unit prices, behave in opposite directions. For example, one subpopulation is subject to price competition while the other subpopulation is subject to quality competition. Again, a robust technique of estimation should be used to separate these subpopulations. The *PX* and *PM* tests, taken in their interaction, can therefore provide highly relevant information about the prevailing strategies of market adjustment at the level of enterprises, even though that information need not be always complete.

5.2 Factor Requirements, FDI and Tariffs

Relative factor requirements of production, measured by capital-to-labour (*K/L*) ratios, are the exclusive determining factors in the Heckscher–Ohlin models of trade specialisation based on supply-side characteristics. If a country is relatively better endowed with labour, then according to the Rybczynski theorem and the Stolper–Samuelson theorem it is assumed that the domestic labour cost / capital cost ratio is lower than that abroad and the country has comparative advantage in labour-intensive products.

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[9] Such a result can now also have an impact on policies for a longer period: the losing industry with no quality adjustments can survive by decreasing its costs either by increased productivity or by decreased labour costs. In addition there are further alternatives: the losing industry can lobby for currency depreciation or for a subsidy.

It is traditionally assumed that the Czech Republic is a country relatively better endowed with labour – see Drabek (1984), Benacek (1989), or Stolze (1997), if the international comparison of *K/L* endowments is made as a trade-weighted average usage of factors. Relative to the EU, it is expected that Czech exports should be biased towards labour-intensive products. We cannot be as certain about the sign with the rest of the world. Our test is therefore a test of the relevance of how the K_i/L_i ratios of specific factor requirements of individual industries are important for determining trade patterns.[10]

The previous variable of *K/L* requirements will not give complete information on the position of the isoquants of the production functions in the production space if we do not know how the individual isoquants may shift over time by total factor productivities (TFP). This is the Ricardian parameter of specialisation based on different gaps in productivities.

Since at this stage of the research we do not estimate the TFP directly, we have to find a proxy variable that would be highly correlated with the TFP. We found that proxy in the FDI industrial stock – see Benacek *et al*. (2000). The stocks of FDI, complemented with the variable of relative factor requirements, are thus able to provide all the relevant supply-side characteristics of production necessary for the determination of comparative advantages and their impact on exports.

FDI can reflect the qualitative aspects of managerial skills, the ability to penetrate world markets, and the quality of the physical capital. In the export function, the presence of a large FDI stock in an industry should boost its exports, since FDI location is attracted by comparative advantages and by the potential for growth they offer.

The role of FDI_{it} in the import function is much less obvious. There are four reasons for this: (1) The lack of FDI stocks may be a sign of comparative disadvantages in the industry and thus imports should be large there; and (2) in the long term, FDI inflows can become a substitute for imports in the given category of products *i*. For these two reasons, the sign of FDI in the import equation should be negative. (3) FDI can be a complement to imports of investment goods (machinery) and inputs (material) in the short term. In addition, FDI can also boost imports of inputs in subcontracting industries. This may especially be our case, because the NACE two-digit classification of products is too broad, and outputs and inputs can often fall into the same industry. And (4) modern specialisation is marked by intra-industry trade. Thus an industry whose exports are boosted by FDI may also become subject to intensive import flows in similar commodities. In both of these cases the expected sign for FDI should be positive.

As a result, we cannot be certain *a priori* about the expected sign of FDI in the import function, even though FDI can be assumed to be an instrument for balance-of-trade improvements and exchange rate appreciation.

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[10] Here, our task is the inverse of the standard theoretical reasoning. Instead of measuring the factor endowments relative to trading partners and inferring the industrial patterns of specialisation from them, we estimate the revealed factor comparative advantages in the trade structure and infer the relative factor endowments from them. The non-existence of factor intensity reversals forms part of our assumptions.

The last of our discussed explanatory variables will deal with tariffs (TAR), which are the most common trade policy instruments. They represent an important barrier impeding the penetration of imports onto the domestic market. It is our task to find out how Czech trade behaved as the tariffs with the EU were gradually lifted during 1992–1999 while being kept with the majority of the non-EU countries. We will estimate this influence with the coefficient of elasticity, which should have a negative sign.

The basic models for empirical testing are therefore defined as follows:

$$M_{it}^{w} = \Phi_{M}^{w} \ (GDP_t, RER_t^{w}, PC_{it}, PM_{it}^{w}, PX_{it}^{w}, K_{it}/L_{it}, FDI_{it}, TAR_{it}^{w}, \varepsilon_{it}^{w}) \tag{6}$$

$$X_{it}^{w} = \Phi_{X}^{w} \ (GDP_t^{w}, RER_t^{w}, PC_{it}, PX_{it}^{w}, PM_{it}^{w}, K_{it}/L_{it}, FDI_{it}, TAR_{it}^{*w}, \varepsilon_{it}^{w}) \tag{7}$$

where:

i	...	1, 2, …, 29 are commodity groups at NACE two-digit classification;
t	...	the years 1993 through 2001;
w	...	regions from where the imports originated or to where the exports were directed: $w \in \{EU, RW\}$, that is, the EU and the rest of world (RW);
M_{it}^{w}	...	Czech imports from w (in current CZK);
X_{it}^{w}	...	Czech exports to w (in current CZK);
GDP_t	...	Czech GDP in CZK at constant 1995 prices, measuring the real aggregate demand absorption capacity;
GDP_t^{w}	...	aggregated GDP in EUR for countries w importing Czech products, measuring their aggregate demand absorption capacity;
RER_t^{w}	...	the effective real exchange rate index based on the CPI and related to the currencies of the given trade partners (increase means appreciation);
PC_{it}	...	Czech price changes in industries i (as price deflators, where the base year 1994 has index 1.00), measuring the intensity of nominal convergence;
PM_{it}^{w}	...	unit prices in CZK per tonne, measuring the type of competition (in prices or in quality). In the import equation it is the strategy used by foreign penetration onto Czech markets. In the export equation it is a proxy variable for foreign competition to Czech exports abroad;
PX_{it}^{w}	...	unit prices in CZK per tonne, measuring the type of competition (in prices or in quality). In the export equation it is the strategy used by Czech exporters abroad. In the import equation it is a proxy variable for Czech domestic competition to foreign imports;
K_{it}/L_{it}	...	capital (at constant 1994 prices) per unit of labour, characterising the domestic technologies and their relative factor requirements;
FDI_{it}	...	foreign direct investment stocks (in CZK), serving as a proxy variable for human capital;
TAR_{it}^{w}	...	Czech tariff rates on imports from w, or average foreign tariffs levied by countries w on Czech exports;
ε_{it}^{w}	...	random term.

It should be stressed that these models are constructed primarily as explanatory models and not as predictive models. They attempt to capture a logically closed set of behavioural factors on both the supply and the demand sides determining the intensities of exports and imports in their structural alternatives for specialisation. There will be two aspects of our analysis: structural (static) and dynamic. The reason for this is that it is a characteristic of a small open economy that its dynamics of trade are constrained not so much by aggregate supply or demand as by the structural constraints on efficient specialisation.

Thus, with the exception of aggregate demand, all our remaining variables describe the factors underlying changes in prices and costs. The hidden objective function of trade and specialisation is the potential for profit maximisation. As this potential changes, labour and especially capital adjust to it on the international scale.

In the first phase of our estimations, the functions Φ^w will be specified as power functions with the coefficients as exponents. Such a model can be linearised by taking natural logarithms of all the variables, except for those that already have the form of annual growth rates. By making this transformation, we have actually modified the hypothesis tested: instead of estimating the coefficients on the absolute values of the variables, we now estimate the coefficients on the growth rates of these variables. The coefficients of such transformed variables can thus be interpreted as coefficients of elasticities. This specification better reflects the non-linear factors underlying the interdependencies of growth and weakens the dependence of the estimators on industry size.

5.3 Policy Relevance of the Models

Taken from the view of the national bank, the model has the following links to policy relevance:

a) The RER variable is the key variable describing the link between the monetary and real sectors. For example, an RER appreciation means decreasing competitiveness of domestic exports or import substitution.[11] In order to keep competitiveness unchanged, the effects of the appreciation should be compensated for by productivity improvements, such as gains in total factor productivity or in labour productivity. Alternatively, they can be also compensated for by decreases in wages, which is in turn reflected in improvements in unit labour costs. Although at this stage of the research we did not aim to quantify directly all these compensatory moves, we were able to illustrate the circumstances of how the RER appreciation could be neutralised by countervailing moves via FDI inflows (i.e., by human capital imports), price/quality improvements, autonomous deflation in industries or by structural adjustment in trade;

b) The variable of foreign aggregate demand for Czech exports is one of the most important mechanisms of international shock transmission. The estimated coefficient of income elasticity reveals the extent to which the Czech economy depends on such exogenous shocks and whether such shocks can be idiosyncratic, hitting just specific industries whose demand is

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[11] Although the appreciation pressure is equal on all traded commodities, its impact on prices and sales depends on the elasticities of supply and demand, which are specific to commodities and countries, as explained by the Marshall–Lerner–Robinson conditions.

too sensitive to income changes. According to the optimum currency area theory, asymmetry in shocks can become a serious argument against prematurely entering the ERM II or firmly fixing the exchange rate;

c)   An expansion of both exports and imports in a small country leads to price convergence, especially if domestic prices are below the price level in the partner countries. A positive sign on the coefficient of price changes could signal the intensity of the nominal convergence in the sectors;

d)   If the national bank wants to retain its independent monetary and exchange rate policy (i.e., if the exchange rate floats or its pegging is soft), then we should be aware of how efficient monetary policies can be. For example, what is the trade balance effect of a depreciation, or potentially, if this model is slightly extended, how might exports respond to an expansion in the real money supply?

e)   Since trade intensities, trade structure and trade prices depend significantly on variables associated with endowments (*K/L*, *FDI*, human capital), it is crucial for policy-makers to anticipate their long-term development and estimate their impact on the balance of trade and the expected degree of restructuring necessary.

To summarise the specification of the models. It is of a paramount importance in econometric hypothesis testing that the specification of the model involves a full set of real causal influences – i.e., there is not a single substantial variable left out that would be non-random. The current state of the art of economic theory helps us to approach this objective.

The present microeconomic theories of trade are able to "explain" the specialisation pattern quite well, but unfortunately are not so good at explaining trade intensities. Combining them with macroeconomic theories (open economy absorption, real exchange rates and the elasticities approach to the balance of trade) is unavoidable.

In our specification we commenced by placing the Heckscher–Ohlin hypothesis at the forefront. Although we do not measure Czech relative endowments, it is assumed that the relative factor inputs of exports and domestic import replacements reflect perfectly the country's relative position in endowments.

Thus the factor requirements (*K/L*) and FDI stocks (a proxy for human capital) became our core variables, defining the structure of the potential for trade on the Czech supply side. The real intensities of trade are then determined by the parameters characterising the demand side: aggregate demand (GDP), the pricing policies of enterprises (*PX, PM*) and effective real exchange rates (RER), which affect both demand and supply.

Since the RER is a global parameter common to the whole economy, sectoral price changes (PC) were added as an industry-specific variable. Last but not least, tariffs were taken as the policy variable that modifies the "natural" trade flows.

The whole economic problem can be explained on the supply side by a Lerner–Pearce unit-value diagram in the domestic currency.[12] Our basic idea is based on monitoring how the isoquants of production and isocost lines move in time and space, and how their position reflecting scarcities and efficiency is related to the pattern and intensity of trade.

The distribution of the isoquants is caused by different factor requirements, and their shifts are caused by technical change and/or by the presence of FDI,[13] exchange rate fluctuation and domestic price level changes. The isocost lines of industries are shifted by changes in their sectoral prices of labour and capital. On the demand side there are the effects of aggregate demand absorption, tariffs and the pricing policies of exporters and their competitors (*PE* and *PM*).

Taken from these purely theoretical (behavioural) aspects, the specification of our models at this first stage is incomplete because of the missing link to efficiency or costs. For example, in the next stage we should add the parameters of wages and capital rental costs, which determine the position of the isocost lines.

6. Tests of the Models of Czech Trade with Fixed Effects of Time [14]

The choice of estimation technique for the coefficients in our models is crucial and subject to the nature of our data. As mentioned, in their economic contents our data are primarily cross-sectional indicators defined for 29 sectors. It addition, they are pooled by years (1993–2001). The estimation of such data can be best approximated using panel techniques – see Wooldridge (2002). The problem is explained in Figure 3, where we limit the whole EU export function to the core explanatory variable of factor proportions: $X^{EU}_{it} = a + b\ K_{it}/L_{it} + e_i$, where *a, b* are the estimated coefficients.

The dots in Figure 3 are stylised observations. According to the Heckscher–Ohlin hypothesis, the intensities of exports (representing the specialisation) are not indifferent to factor requirements. For example, in a country relatively better endowed with labour relative to capital, the majority of exports should be concentrated in the textile industry, which is labour intensive. The higher the *K/L* requirement is in a given industry, the lower that sector's engagement in exports. The model should then be estimated then as cross-sectional data pooled by time – depicted in Figure 3 as a series of downward-sloping lines (e.g., by the thick intermittent line X_{1997}). The complication is

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[12] This is a standard approach used in the multi-industrial analysis of specialisation and trade in small open economies, as introduced by Jones (1974) and Leamer (1995).

[13] The effect of both can be quantified by the total factor productivity indices. FDI can be interpreted as human capital that improves technical efficiency and shifts the isoquants closer to the origin. In addition, FDI can be interpreted as "network capital" acting on the demand side by opening markets to both export and import penetration.

[14] The econometric estimations prepared for the interim report on this project were based on our preliminary data for 61 industries in the SITC classification and in USD. Since the Czech balance of trade is in current CZK and the majority of data come from enterprise statistics, we decided to build an alternative database for 29 industries in the NACE classification. The provisional estimations revealed that the economic relationships and the technical shortcomings in the SITC data were similar to those of the NACE data set, showing that the fundamentals of the problem and the data were isomorphic and robust enough to avoid a loss of quality due to mere alternative reporting methodology or aggregation pattern.

that there is also a time dimension for each industry. The *K/L* ratio may then grow in time, what also has an impact on exports. For example, this can be depicted by the upward-sloping thick intermittent line representing trade in food. By estimating the model alternatively, either in cross-section or in time-series, we may get very different coefficients *a, b* that actually represent very different economic hypotheses.

Figure 3: Dimensions and characteristics of panel data
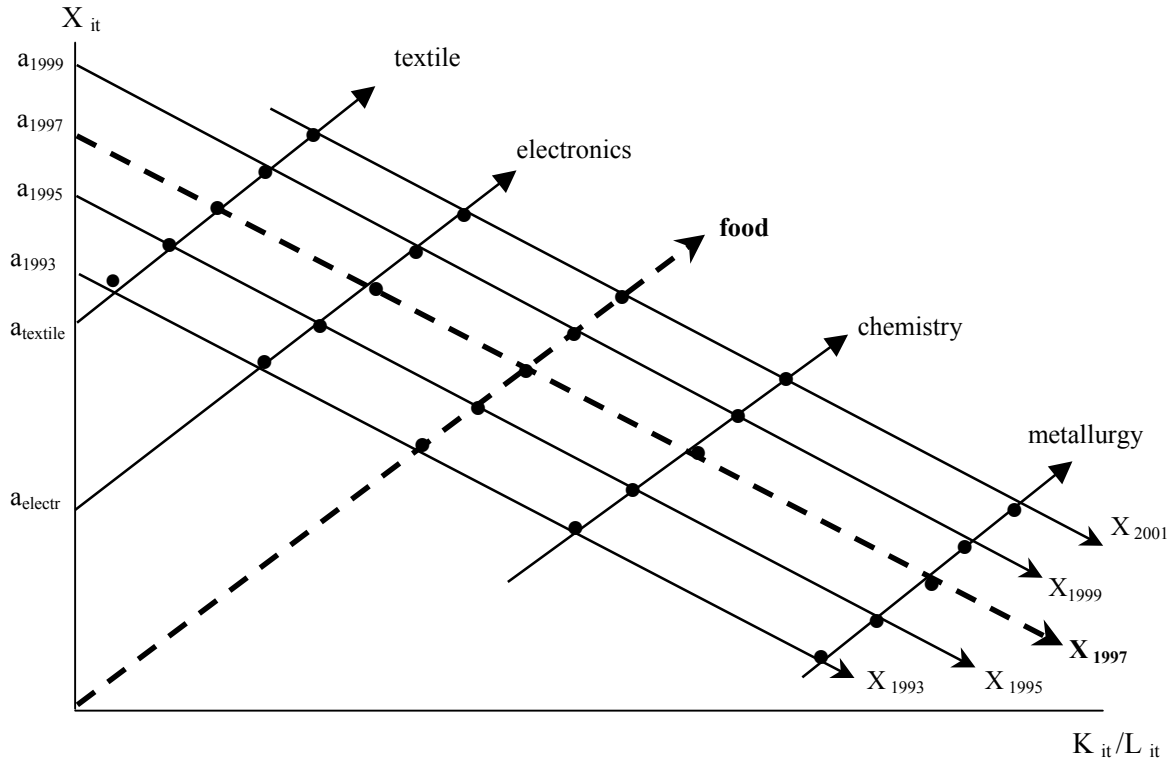
The estimation technique of fixed effects described e.g. by Wooldridge (2002) eliminates the bias caused either by time or by idiosyncrasies of individual industries. In the case of "fixed effects" of time, it is assumed that the behavioural characteristics are the same for all industries, except for the "vertical shift" in individual years. Thus, by means of time dummies we estimate additional intercepts (a_t) for each year t, aligning the series of cross-sectional data for 1993, 1995, 1999 and 2001 closer to the "average" (the year 1997 is assumed here as average).

Alternatively, for the proper estimation of variables that have only the time dimension (such as GDP_t and RER_t), we must eliminate the "shift" in data caused by behavioural specificities of individual industries. Therefore, we estimate the model with fixed effects by individual industries; then the estimated coefficients are unbiased and consistent. Thus, by means of industry dummies we estimate additional intercepts (for example, a_{electr} for electrotechnics during 1993-2001), aligning the time series of individual industries closer to the "average" (food industry is assumed here as average). Unfortunately, the trade-off for gains from using fixed effects is that the estimates are not efficient. Although the structure of the model is correct, we are still left uncertain about the "true" error variance. Therefore, we are obliged to raise the following caveat to the readers: at this experimental stage of research, the statistical significance of coefficients with fixed effects must be taken with caution.

Both approaches to estimating the fixed effects have their own practical outcomes. As Figure 3 shows, structural and time analyses of behaviour can lead to very different results – for example, the estimated slopes can differ not only in magnitude but also in sign. This may happen if the initial structural characteristics of the studied object change over time. The analysis of structural patterns (i.e. the downward-sloping lines) offers a static picture that can serve as a benchmark. The consecutive analysis of time patterns (i.e. the upward-sloping lines) offers a dynamic outlook that is more appropriate for making predictions. Nevertheless, both analytical views are necessary complements for finding "where we have come from" and "where we are headed".

Here, in the first stage of our estimations, we concentrate on the cross-sectional (industrial) characteristics of our models, estimating the specification with fixed effects of time. In this way, we identify which structural characteristics are common to the functioning of Czech exports and imports after we eliminate the specific influence of time on them. Before describing the procedures and results of our econometric estimations we must discuss some further features common to all the regressions. These concern the significance of fixed effects, the significance of factor endowments and FDI, and time autoregressivity in the industrial structure of trade.

Concerning the estimation of fixed effects of time, we find that there are no behavioural patterns in the data that could be explained by the time factor alone. The coefficients of such fixed effects are statistically insignificant in all four of the models we test, and we have to exclude them from the final estimation. Although this is not a fully satisfactory outcome (e.g., due to the retained lower efficiency of estimates), we consider the result a conclusion of a certain experimental stage that offers non-trivial insights into the analysis of Czech trade and the methodology used here. It is a sort of second-best solution that is the best in the given context only – within the given class of linear static estimates. Applying more complicated non-linear dynamic estimation techniques might offer a different description of the real functioning of Czech trade.

Let us now discuss the remaining features common to all our models. All the estimations in our import and export functions with the EU and RW resulted in coefficients that were highly significant for both the *K/L* factor requirements and the FDI stocks. Their fundamental influence on the pattern of specialisation was clear-cut, and the tests for co-integration also could not refute their role by finding technical reasons for a biased estimation in these key indicators.

In all the equations for trade with the EU, the *K/L* variable always have a negative sign, pointing to an intensive labour intensity of the Czech specialisation pattern. This is not surprising for exports, because this has been their fundamental property ever since the 19th century. The parallel factor labour intensity of exports and imports is, nevertheless, a paradox. There are also other questions that need special comment.

6.1 Factor Endowments, FDI and Trade

The mystery about the parallel labour intensity of exports and imports is caused by the fact that at this stage of the research we cannot directly test the inner structure of the labour content. For example, we cannot test whether the labour requirements in imports were significantly more biased towards workers with high skills than is the case in exports. All the indirect evidence about unit prices, however, leads to the conclusion that this is true.

Hence the Czech labour content in exports to Western Europe cannot be considered to be crowding out the same type of labour required for the EU exports to the Czech Republic. Similarly, rising EU import penetration on the Czech market contains a disproportionately larger amount of skilled labour than is its contents in Czech exports to the EU. By accepting imports from the EU, Czech economy gains the services of missing human capital and gets a chance to use its abundant labour more intensively by concentrating on exports. It is mainly less- and medium-skilled workers whose wages and jobs benefit from the past increase in specialisation with the EU.

Another aspect of factor endowments concerns the question of what will happen if the relative factor endowments change over time, which is explained by the Rybczynski theorem. If the Czech labour supply stagnates while at the same time the Czech propensity to invest is one of the highest in Europe, then the structure of trade and production will respond to these fundamental factor changes very sensitively. Rising wages and abundant investments will press not only for factor substitution, but also for a restructuring of exports in favour of more capital-intensive products. At the same time, domestic import substitution will not strengthen sufficiently because imports are not so capital intensive. The pressure for an exchange rate weakening during the transition period will be marked. The only way to strengthen the export and anti-import position is via a build-up of human capital.

FDI is internationally recognised as a powerful engine for both export and import penetration – see Bellak (1999) or Pfaffermayr (1996). In the Czech economy it becomes the most powerful factor behind both the structure and the dynamics of imports. If the FDI is divided between FDI from the EU and FDI from the rest of world, we can see that not only is their structure different (the coefficient of correlation is 0.41), but also the FDI from non-EU countries is less oriented towards imports from the EU.

As our later results will indicate, FDI is also one of the most powerful factors behind the accelerated Czech exports to the EU. At this stage we cannot conclude whether it is also a net contributor to the balance of trade. The most positive in that respect is FDI from non-EU countries, which is a significantly stronger exporter to the EU than the remaining 87% of the FDI stocks from the EU countries.

As a policy recommendation, the promotion of FDI from non-EU countries (e.g., from Asia and the USA) would result in an improvement in the trade balance, as this type of FDI uses more domestic inputs and concentrates more on exports.

In the next four sections we will discuss separately the models of imports and exports, divided into trade with the EU and trade with the rest of world (RW). The latter is still an important part of the Czech economy, currently accounting for 31% of all exports and 38% of all imports.

6.2 Autoregressivity in Imports and Exports

The restructuring of industries is a process that changes the quality of the commodities traded and their geographic orientation. It is not a repetition of past structures. An analysis of the autoregressivity characteristics in our 29 industries throughout the analysed period describes how

past structures have influenced the evolving trends. Table 2 shows the results of simple autoregressive models of imports and exports with a lag of one year.

Table 2: Autoregressive models of trade decomposed into 29 industries
(after logarithmic transformation of the original power function, e.g., $M_{it} = \alpha * M_{it-1} * * b * \varepsilon_{it}$)

		Interc. a	Slope b	Const. α	R^2 (adj.)	DW
$Ln(M_{it}^{EU}) = a + b\ ln(M_{i,t-1}^{EU}) + u_{it}$	Coeff.	0.580	0.950	1.79	0.907	2.85
	t-test	1.343	47.37			
$Ln(X_{it}^{EU}) = a + ln(bX_{i,t-1}^{EU}) + u_{it}$	Coeff.	0.337	0.979	1.40	0.962	1.64
	t-test	1.617	44.21			
$Ln(M_{it}^{RW}) = a + ln(bM_{i,t-1}^{RW}) + u_{it}$	Coeff.	0.596	0.947	1.81	0.956	1.91
	t-test	1.545	22.02			
$Ln(X_{it}^{RW}) = a + ln(bX_{i,t-1}^{RW}) + u_{it}$	Coeff.	0.079	0.999	1.08	0.972	2.08
	t-test	0.877	89.6			

Note: *Estimated by TSP, where the intercept and t-statistics were evaluated by employing a heteroscedasticity-resistant White's covariance matrix.*

The results indicate that exports to the RW were the most stable part of Czech trade throughout 1993–2001, followed closely by exports to the EU. The structural stability of the export growth in all industries (at a level of 29 industries) is evident from their slope coefficient close to unity (0.999 and 0.979).

If the logarithmic model of exports to the EU is transformed into its original power function of $X_{it} = \alpha * X_{it-1} * * b * \varepsilon_{it}$, then the multiplicative constant $\alpha = e^a$ will be 1.40 – implying very fast autonomous growth (unfortunately subject to high random fluctuations). As the autoregressive "core" (estimated by the slope) reproduces nearly all the past values, the component of structural change is nearly fully embodied in the "random" autonomous growth. Thus our task is to figure out these "black box" parameters of the intercepts using our main models by means of economic determining factors.

Imports from both the EU and the RW show even more varied behaviour, determined slightly less by past structures and much more by the "autonomous" structural influences estimated by the intercepts. The pressure for a profound structural revamping of the Czech economy was mediated in the first place via imports (i.e., by crowding out domestic producers).[15]

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[15] We could speculate at this point as to what could be the salient drivers behind such a drastic structural revamping of the Czech economy. It can be gathered from the identity $A = C_D + I_D + G_D + M$ that it was the "domestic" part of production that became the main barrier to growth and the engine of structural change. Actually, it was only the segment of domestic tradables for domestic consumption, since non-tradables and the service sector were growing. Therefore, an expansion of imports was possible only if the volume of domestically produced tradables for domestic usage was sharply falling. It was not so much the structure of Czech exports as the structure of Czech domestic manufacturing sales that had the weakest structural position in the post-communist Czech economy. Stabilisation in the domestic import substitution sector may thus become the key factor in strengthening the Czech external equilibrium, by offering little space to new incoming imports. Also, the expected appreciation of the koruna will depend in the first place on developments in the domestic import substitution sector.

Taken from this technical side, we could therefore add the lagged variable of exports or imports to the list of exogenous variables in our main models and expect them to explain the stationary trend, while the dynamics of the changes will be explained purely by the remaining economic variables. This would be the most helpful when using the models for predictive simulations.

6.3 Model of Czech Imports from the EU

The data for empirical testing are for 29 commodity groups (NACE industries) of the Czech economy in a 1993–2001 time series. The data available are thus a combination of cross-sectional and time-series statistics. Therefore, we arrange the data as a segmented panel, which means that we create consecutive sections of 29 blocks, one for each industry, each containing a sequence of 9 rows for the individual years. Economic information about every industry (block), described by indices *i*, was therefore contained in the columns. Altogether we had 261(29 x 9) observations.

Each of the columns thus represents one variable – starting with import values (as the endogenous variable) and continuing with the explanatory variables: import and export prices, indices of price changes, FDI stocks, Czech tariffs, capital-to-labour (*K/L*) ratios, Czech GDP and the RER of the koruna against the euro.

In the first step, we estimate the regression coefficients using the OLS method with fixed effects of time. We test the sensitivity of our model to four theoretical fundamentals, such as the importance of aggregate demand, the real exchange rate, K/L endowments and FDI. In addition, we test the significance of the autoregressive links between imports and exports.

6.3.1 Nature of the Aggregate Demand for Imports from the EU

Here, the Keynesian macroeconomic view is simple: an increase in Czech aggregate demand (the volume of GDP at constant prices) spills significantly disproportionally into demand for imports. However, according to Engel's law, Vernon's product cycle hypothesis and Linder's representative demand (see Linder (1986) for a summary), there are good reasons to expect that this relationship is not linearly uniform for all industries.

Moreover, according to the Rybczynski theorem, the growth induced by a change in relative factor endowments can become import-replacing and expand the Czech domestic import-competing production. [16]

This could be the best explanation why in 2002 Czech imports decreased by 3.9% and the trade balance improved by 10.4%, with accompanying gains in the quality of production and terms-of-trade improvements, while the koruna kept appreciating. Is it the first signal of a series of reversals in the past trends shaping Czech international trade during the past twelve years?

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[16] This can happen if Czech factor endowments are converging to the endowment structure of the countries of imports. For example, it may be the case if Czech endowments of human capital (and physical capital) are catching up with the endowments in the EU. The potential for trade would decline. A similar situation occurred in the late 1980s in Ireland, becoming the inception of the "Irish miracle".

In our initial sensitivity testing we combine the real changes in aggregate demand with the nominal changes – that is, by combining real GDP_t with the autonomous price changes in industries (variable PC_{it}) and with the impacts of the real exchange rate (RER_t), whose continuing sharp appreciation (i.e., an increase in the index) should be a major instrument for opening the Czech market up to imports.

Although we find a statistically significant correlation with imports in all three variables, their regression coefficients (when estimated jointly) are largely disappointing. Their p-values – always above 0.3 – indicate practically no statistical significance, and the R^2 is hardly above 0.03, whatever technique we use. The income elasticity of imports is extremely high – in no case is it below 2 and for the majority of manufacturing industries it is around 6.[17] The variable of sectoral price changes is always positive, indicating that Czech aggregate inflation can be explained as a combination of imported prices reflecting the rising quality of imported products and the cost-inefficiency of domestic import-competing production. Unfortunately, there must be many exceptions to this rule, as the significance of this coefficient is extremely low.

It is also evident that industry-specific price changes in the Czech economy are far from being completely neutralised by nominal exchange rate depreciation, as the steadily appreciating RER testifies.[18] We can infer from the paradox of the long-lasting inflation in industries and the actual nominal (and real) exchange rate appreciation that the competitiveness of Czech domestic production both in costs and quality must somehow have kept pace with the rocketing imports, even though this must have been painful.

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[17] As we found in the experiments with SITC data, this elasticity was especially susceptible to bias caused by a serial autocorrelation of the residuals. After estimation remedies, the "true" elasticities declined to 1.18, which looked much more credible and similar to the monthly elasticities estimated by Tomsik (2001). What is certain is that the income elasticities for products with high per-kilogram prices (i.e., those with high value added or at higher stages of manufacturing) are much higher than the income elasticities of primary inputs. Another problem is the accommodation of income growth with the monetary policy of the CNB. Since the money supply grew faster than GDP for the majority of 1993–2001, it would be advisable to include the M2 variable (and perhaps even government spending) in the equation.

[18] Here we should talk about another paradox: why we ever had any positive inflation from April 1999 until 2002, when the nominal exchange rate appreciated from 38 CZK/EUR to 30 CZK/EUR. Evidently, any serious "overshooting" in the appreciation (stemming from capital flows, for example) would have resulted in intensive disinflation and a wage freeze. The existence of any positive inflation in the sectors during this period suggests that the internal accommodation via restructuring, productivity gains and increased quality was intensive enough to leave some leeway for price hikes. Most probably these were nothing less than reflections of the structural gains in quality, goodwill or market domination rents. They became erroneously interpreted by statisticians as "inflation", which superficial observers further transformed into a "loss of competitiveness" and proof of the koruna's overvaluation. If we do not know how to measure prices and inflation "properly", how can we aspire to estimate the Balassa-Samuelson effect correctly? A scenario of an evolution full of similar paradoxes can be depicted as follows: A large domestic producer in a very small country exports 80% of its products at a unit price of EUR 100, just covering its costs. After a take-over by a foreign oligopolist its production at current prices doubles, accompanied by a minor upgrading in quality through the use of imported material only. The price now increases to EUR 150 at home and to EUR 200 for exports, while wages increase by 25%. On the one hand, the real exchange rate based on any of the three prices (all interpreted as "inflation") would point to a need for a nominal exchange rate depreciation owing to a "loss in competitiveness" (which is what the losing domestic producer of material inputs would lobby for). On the other hand, the alternative estimation of the RER by means of unit labour cost, terms of trade or pure productivity gains would point to appreciation. Strangely enough, the market itself would require no exchange rate change at all, because the balance of trade has remained in perfect equilibrium throughout.

Unfortunately, it was not only due to these specific economic conditions that the estimation of the RER variable is so highly unsatisfactory. Its sign fluctuates between positive and negative values, which implies low significance and contradicts the theory of PPP that real appreciation is a cause of increased imports. As the RER appreciate over time, accompanied by accelerated imports from the EU, we are not able to summon an econometric confirmation that this relation might be the dominant force driving the Czech balance of trade towards deficit.

There could be two reasons for that failure: (a) there must exist some more dominant forces that determine the dynamics of Czech imports and that make the influence of RER insignificant; (b) the technique of estimation we chose is not sensitive enough for capturing all the information hidden in the panel data. The alternative estimation by means of fixed effects by industries would be more appropriate for unveiling the interdependence of aggregate demand, RER and import growth.

Here, we can only conclude that, at this level of model specification, neither Czech aggregate demand nor the real exchange rate appreciation performed as leading drivers of imports. The results in the second stage of estimation (described in Table 12) are more successful in that respect.

6.3.2 Cointegration between Imports from and Exports to the EU

High interdependence between imports and exports from the same industry is a sign of a high degree of intra-industry trade. Given our low level of disaggregation to a mere 29 industries, we cannot say much about the nature of intra-industry trade. We can only assume from the different unit prices that the trade flows inside the same industry cannot be in identical products and that there must be a tendency to vertical differentiation.

Evidently, EU imports of high quality are exchanged for Czech exports of medium or low quality. Table 3 presents the results of a regression ($M_{it}^{EU} = \beta_1 + \beta_2 * X_{it}^{EU} + \varepsilon_{it}$) in which imports from the EU are related to Czech exports to the EU.

Table 3: Dependence between imports and exports in trade with the EU
         (linear model, dependent variable: M_{it}^{EU})

Variables	Estimated parameters	Standard error	t-statistics	P-value
Intercept	3071.6	943.2	3.256	[.001]
X^EU	0.7574	0.080	9.412	[.000]
Std. error of regression	12477	**Adjusted R-squared**		0.674
F-test	538.8	**Durbin–Watson test**		0.456 [19]
Normality test χ²	0.139	**Observations**		261

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[19] See the next footnote for more explanation on the D–W statistics.

In an alternative non-linear specification of the above model, we also estimate the coefficient of elasticity between imports and exports. Its value of 1.143 implies that the interdependence between exports and imports from the EU is very high. An attempt to increase exports to the EU by 1% is associated with EU imports rising by 1.143%. Of course, we cannot interpret this as a cause-effect relationship (the imports are not evidently inputs to exports), but this relationship does point to a tendency of unbalanced trade with the EU over time.

The difference is striking if we compare it with the balancing mechanism in trade flows with the rest of the world. For the RW, the same linear relationship between imports and exports leads to coefficients of 5.660 and 0.593, with an "elasticity" of only 0.815. The trade with the RW therefore had much smaller problems with the balance in its growth over time.

We can conclude from the above evidence that Czech trade, at least with the EU at this level of aggregation, cannot be explained by the Ricardian paradigm of homogenous products and identical degrees of comparative advantage or disadvantage inside the product groups, which would lead to inter-industrial specialisation.

We should give more consideration to the more modern theories of trade, including an estimation of the coefficients simultaneously for both exports and imports. Nevertheless, it is evident that there is a convergence in both the trade patterns and quality in trade with the EU, as Table 4 reveals.

Table 4: Evolution in volumes traded and unit prices in the Czech exports and imports with the EU

Year	X tonnes mil.	M tonnes mil.	X price per kg in CZK	M price per kg in CZK	M/X relative kg price	Growth in X price
1993	20.63	4.45	10.77	53.78	4.99	n.a.
1994	26.13	5.76	10.30	51.49	5.00	-4.4%
1995	25.07	6.42	13.66	63.20	4.63	32.6%
1996	22.79	7.59	15.47	62.09	4.01	13.3%
1997	23.10	8.79	18.36	60.43	3.29	18.7%
1998	23.47	9.35	22.75	62.07	2.73	23.9%
1999	25.53	10.36	24.63	60.31	2.45	8.3%
2000	25.80	11.05	29.79	69.70	2.34	21.0%
2001	25.07	11.95	34.91	71.71	2.05	17.2%
2002	23.60	12.17	36.28	65.57	1.81	3.9%

Source: *Czech trade statistics, own calculations. CSU; Prague, 2002.*

While the physical volumes of exports to the EU went down after 1994, their total value increased 3.94-fold and the per-kilogram prices increased 3.38-fold between 1994 and 2001. Therefore, the structure of exports must also have shifted in favour of products of higher quality or higher value added per unit. No such breakthrough can be seen in Czech imports, where shifts to products of higher quality (above the long-term inflationary trend) can be seen only in 1995 and 2000. The

catching-up of the Czech economy with the EU progressed visibly throughout 1993–2001. The ongoing appreciation of the koruna was only a small part of the profound changes.

6.3.3 Complete OLS Test – Imports from the EU

The test of all model variables for imports from the EU brought the results shown in Table 5 (after removing the statistically insignificant variables, including the insignificant fixed effects).

Table 5: Results of the model for imports from the EU with fixed effects of time
(OLS logarithmic estimation, dependent variable: ln M_{it}^{EU})

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
Intercept	42.18	8.22	5.13	.000
M price/kg	.370	.186	1.99	.048
X price/kg	-.409	.170	-2.41	.017
FDI stock	**.445**	**.032**	**14.11**	**.000**
Tariffs CZ	**-7.575**	**1.78**	**-4.25**	**.000**
K/L ratio	**-1.736**	**.144**	**-12.08**	**.000**
Std. error of regression	1.330	**Adjusted R-squared**		0.528
Normality test χ^2	0.357	**Durbin–Watson**		0.530
White heterosc. test	99.5	**Observations**		261

The results from the OLS estimation offer interesting material for economic interpretation, notwithstanding the fact that our results are often subject to problems with autocorrelation of the residuals.[20] Fortunately, the p-value of normality test χ^2 is significantly higher than the critical value of 0.05, which implies that the error terms are normally distributed and the model can be accepted. We should stress that even the "naive OLS estimations" (i.e., neglecting the interdependence in disturbances) described in this section still remain unbiased and consistent. Only the standard error and significance tests become biased. Therefore, our second-best OLS estimations still offer important information that may be lost if any sophisticated correction routines are applied.

We test the data for homogeneity of patterns by splitting the time series into two periods: 1993–1996 and 1997–2001, representing two different governments and their approaches to transition policies. The first ("conservative") period was characterised by fast growth, balanced budgets, modestly expansionary monetary policy, "banking socialism" and a failing judiciary. The following period was marked by a reversal in these characteristics.

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[20] It must be admitted that the D–W statistics cannot be measured accurately in our segmented panel data. One ninth of the D–W statistics (due to the nine years of observation) are based on "randomly positioned" data – that is, on data from two different industrial blocks and therefore also out of the time sequence. However, if we also assume that the nature of this disturbance is truly random, then the ensuing bias should not pose a major threat to the significance of the D–W statistics. Nevertheless, we can never be fully certain that this was true in each particular case. Additional tests of the models – attempting to remedy the problems of autocorrelation and heteroscedasticity – are described in Section 7.

Strangely enough, the intensity of trade with the EU is not significantly influenced by these substantial institutional changes, even though some minor behavioural differences are evidently present. The three factors with the highest t-significance (i.e., FDI, endowments and tariffs) show high stability throughout. In contrast, the variables associated with GDP, RER and industrial price changes are volatile in both significance and signs. Since these three variables are fundamental factors both for macroeconomic theory and for the decision-making in the national bank, we will discuss their functioning again in the second stage of our estimations.

Surprisingly, the EU imports are labour intensive. Actually, the coefficient here have the highest absolute value, which may sound like a paradox *vis-à-vis* the labour-intensive Czech exports. The clue to solving this conflict is provided by the price variables. Their dual significance reveals that the imports from the EU are of high quality and the domestic competition based on vertical differentiation does not pose a serious threat to them.

The negative sign for the PX variable reveals that these imports were not competing with the Czech products, because their quality was inverse to the comparative advantages of the EU products. Import substitution thus has a difficult starting position for striking a change.

Hence the pattern of Czech specialisation in trade with the EU is actually formed by human capital (not tested directly at this stage), whose endowments between the Czech Republic and the EU were very different, especially at the beginning of the transition. The question is whether the convergence in human capital endowments (e.g., via FDI) are fast enough to reverse the Czech specialisation to patterns of a more modern type.

6.4 Model of Czech Exports to the EU

6.4.1 Nature of the Aggregate Demand in Exports to the EU

When we test the present model with the full list of variables, the role of aggregate demand usually subside to a very low statistical significance. Actually, that is a general property of aggregate demand in all of our trade models based on fixed effects of time. However, when we test the variable of aggregate demand separately, the foreign aggregate demand for Czech exports is significant. For example, the elasticity coefficient *b* in the model

$$ln\ (X_{it}^{eu}) = ln\ (a) + b*ln\ (GDP_t^{eu}) + ln\ (\varepsilon_{it}^{w}) \tag{8}$$

is 2.9, with t-statistics of 4.8. It also increases proportionally with the degree of manufacturing and the value added. For example, it ranges from 1.8 for the primary processing industries up to 4.1 in the industries with high degrees of processing. The R^2 follows suit, ranging from 0.02 to 0.28. Therefore, we should be aware that the relationship between Czech exports and foreign aggregate demand is much more complicated than can be shown by a simple macroeconomic analysis.

The variable that behaves most "disappointingly" is the RER. It should have a highly significant negative sign. In theory, a larger appreciation of the koruna against the euro should incapacitate exports to the EU. In contrast, our coefficient is either insignificant (and negative) or slightly

significant but positive. Here, we are challenged by the paradox that the koruna was constantly appreciating while exports kept growing. That would suggest that during 1993–2001 the koruna was either appreciating along its new equilibrium level (supported by gains in productivity, quality and the terms of trade) and/or foreign demand was highly inelastic to import price increases.

Both cases would be consistent with the sharply rising per-kilogram prices (and quality) of Czech exports, as shown in Table 4. Let us also mention that the correlation between Czech exports and imports is very high (see Table 3), pointing to intensive intra-industry trade that is not very sensitive to RER changes. Further investigation is needed to uncover the background of these crucial problems.

6.4.2 Complete OLS Test – Exports to the EU

Czech exports to the EU are explained by a simpler model than that used for imports. Unfortunately, the estimation using the full list of variables is biased due to colinearity between some of the variables, which requires specification adjustments. The correlation between prices – that is, between *ln(PE)* and *ln(PM)* – was 0.96793; similarly, it is too high between *ln(GDP$_{EU}$)* and *ln(DEF)* and between *ln(GDP$_{EU}$)* and *ln(RER)*. After removing in a stepwise fashion the statistically least insignificant and collinear variables (export prices, inflators and RER, but retaining all fixed effects that are at the margin of insignificance), we get a narrower specification of exports to the EU by OLS. As shown in Table 6a, the dominant factors come from the supply side: from FDI and other factor requirements, plus from the EU tariff concessions that commenced in 1992.

Table 6a: Results of the model for exports to the EU with fixed effects of time
  (logarithmic estimation, dependent variable: ln X_{it}^{EU})

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
Intercept	19.32	4.585	4.21	[.000]
X price/kg	-0.073	0.034	-2.15	[.033]
FDI stock	**0.267**	**0.019**	**14.35**	**[.000]**
Tariffs EU	**-4.409**	**0.340**	**-12.96**	**[.000]**
K/L ratio	**-0.930**	**0.071**	**-13.08**	**[.000]**
GDP EU	1.059	0.450	2.35	[.019]
Std. error of regression	0.805	**Adjusted R-squared**		0.630
Normality test χ²	0.090	**Durbin–Watson**		0.491
White heterosc. test	74.0	**Observations**		261

From this operation, we can see that the export prices and GDP of the EU become significant, while the core of the export determinants (FDI, decrease in EU tariffs, and *K/L* endowments) remains nearly invariant to such specification changes. The paradox of the "clash" between the parallel labour-intensive nature of both Czech exports to the EU and Czech imports from the EU is already explained in the model for imports from the EU. Our reasoning based on the human

capital and the different types of competition in prices and quality is confirmed by the results from this model, as will be shown next.

The negative sign on the export price variable suggests that Czech exports to the EU are in industries where competing domestic products are not of high quality (or of high value added). Another explanation could be that the export competitiveness is gained by lowering prices relative to those of competitors. Unfortunately, there is a small snag here, since the export prices are in the domestic currency (CZK) and are subject to nominal exchange rate fluctuations. If the exchange rate appreciates nominally, it would influence both the RER and the *PX*. Fortunately, we do not find an unacceptably high correlation between these two variables.

This suggests that the mild nominal exchange rate fluctuations during 1993–2001 could not have lent a significant bias to our estimation and that the parallel competition with low quality and with price concessions was a real problem with Czech exports to the EU.

The GDP of the EU is another significant factor that should be considered. Its elasticity slightly above unity (1.059) implies that fluctuation in the growth of the EU economies would have only a minor influence on Czech exports, what is not very credible. Therefore, more sophisticated tests are needed in order to confirm that the income elasticity of exports to the EU was not higher. Aggregate foreign demand is not uniform across all products, but varies from product to product in its Engel effects. As we will see next, the problem with income elasticity is intertwined with the mystery of RER, which will be revealed in an alternative specification of this function by replacing GDP by RER:

Table 6b: Alternative specification of the model for exports to the EU with fixed effects of time
(logarithmic estimation, dependent variable: ln X_{it}^{EU})

Variables (logs)	Estimated parameters	Standard Error	t-statistics	P-value
Intercept	21.47	3.764	5.70	[.000]
X price/kg	-0.073	0.034	-2.14	[.033]
FDI stock	0.267	0.019	14.38	[.000]
Tariffs EU	-4.412	0.340	-12.96	[.000]
K/L ratio	-0.929	0.071	-13.03	[.000]
RER	1.556	0.668	2.331	[.021]
Std. error of regression	0.799	**Adjusted R-squared**		0.621
Normality test χ^2	0.199	**Durbin–Watson**		0.488
White heterosc. test	71.3	**Observations**		261

As is evident from Table 6b, the cross-industrial variables of GDP_{EU} and RER are crowding each other out in the "explanation" of Czech exports to the EU, owing to their extremely high correlation. Nevertheless, they are two theoretically distinct influences on exports, and dropping one of them introduces a specification error into the equation. In fact, doing so assigns a conflicting simultaneous influence of both variables into the included one.

In addition, the positive sign of the real effective exchange rate of the euro is paradoxical: its appreciation of 29.4% during 1993–2001 is interpreted in our model as an instrument of export promotion (!), which definitely could not have been the case. In the case of retaining GDP and dropping the RER (see Table 6a), the specification error would explain why the estimated income elasticity is so low: this already includes the RER effect, which must be negative. Thus the much higher real income elasticity is suppressed by the excluded RER variable, which in fact has a negative influence.

On the other hand, by keeping the RER and excluding GDP, the RER's negative impact is outweighed by the missing positive impact of GDP. To reveal the real income and real exchange rate elasticities, we have to remedy the whole estimation by estimating the coefficients with the help of fixed effects by industries.

6.5 Model of Czech Imports from the Non-EU Countries

In this model, we again have a similar problem in finding the relationship between imports and domestic aggregate demand or the RER. Though individually they have a statistically significant link to RW imports, they are outweighed by other factors or distorted by too many defaults in our data in the more complex specification of the model.

For example, we can see that imports from the non-EU countries are evidently less determined by uniform economic factors than are imports from the EU. The conglomerate of eclectic economies included in this group poses too many distortions for the estimation. That is, most probably, the reason for the unsatisfactory level of the normality test. Its results signal that the error terms are not normally distributed and we can get different results if a non-linear estimation is applied.

Table 7: Results of the model for imports from the non-EU countries with fixed effects of time
       (logarithmic estimation, dependent variable: ln M_{it}^{RW})

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
Intercept	29.530	2.385	12.38	[.000]
M price/kg	0.320	0.104	3.080	[.002]
X price/kg	-0.509	0.127	-4.009	[.000]
FDI stock	0.345	0.048	7.254	[.000]
Tariff CZ	-4.637	0.520	-8.913	[.000]
K/L ratio	-1.071	0.165	-6.495	[.000]
Std. error of regression	1.212	**Adjusted R-squared**		0.348
Normality test χ^2	0.000	**Durbin–Watson**		0.441
White heterosc. test	166.4	**Observations**		261

We can see that tariff liberalisation becomes an important policy move for intensifying these imports. The introduction of the EU structure of tariffs against imports from the non-EU countries after accession in 2004 may therefore become an important instrument for change in the present structure of trade with these countries and for diversion towards the EU members. That, in turn,

may be the source of a minor wave of structural adjustments in the Czech structure of production and material inputs.

It is furthermore evident that the conditions on the domestic supply side were as decisive here as for imports from the EU. FDI is highly significant, and the negative sign for the K/L requirements indicates that imports from the non-EU countries were again dominated by labour-intensive products.

This would be a natural expectation, since a large part of these imports comes from developing and other transition countries. Imports from other non-EU developed countries may also remain labour intensive, because they are based on human capital, as were the imports from the EU. The only region with exports to the Czech Republic biased towards capital-intensive products is Russia and Ukraine. Their weight is too small to influence the whole group of non-EU countries.

The results of the price variables are very similar to those for imports from the EU. It is confirmed again that domestic production is generally challenged by imports in competition based on parameters of quality.

6.6 Model of Czech Exports to the Non-EU Countries

The structural pattern in this segment of Czech trade is determined by just three factors: FDI, factor endowments and tariffs of the importing countries. It also reveals a strong resilience to exchange rate changes and to GDP fluctuations in the partner countries.

Table 8: Results of the model for exports to the non-EU countries with fixed effects of time
     (logarithmic estimation, dependent variable: ln X_{it}^{RW})

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
Intercept	10.665	0.828	12.882	[.000]
FDI stock	0.357	0.025	14.115	[.000]
Tariffs RW	-0.889	0.180	-4.942	[.000]
K/L ratio	-0.646	0.098	-6.609	[.000]
Std. error of regression	0.993	Adjusted R-squared		0.494
Normality test χ^2	0.000	Durbin–Watson		0.440
White heterosc. test	65.3	Observations		261

Trade with the rest of world resembles the Heckscher–Ohlin explanation of specialisation based on factor proportions and inter-industry trade much more closely than does trade with the EU. The structure of exports and imports in trade with the non-EU countries is significantly more differentiated than is found for trade with the EU. There is not a high correlation between exports and imports when their absolute values are compared, as Table 9 reveals.

In comparison with Table 3 (with a similar regression for the EU), the differences between the structural characteristics of trade for these two regions are quite striking. The volume of intra-industry trade with the non-EU countries is small. Nevertheless, if a similar regression is made on the growth of RW imports and exports (not shown here), the tendency for a build-up in intra-

industry trade becomes stronger. We can see that even though the initial conditions for trade with the RW are very different from those with the EU, the actual structural dynamics of trade with the non-EU countries converge to the patterns of trade with the EU.

Table 9: Dependence between imports and exports in trade with the non-EU countries
(linear model, dependent variable: M_{it}^{RW})

Variables	Estimated parameters	Standard Error	t-statistics	P-value
Intercept	5659	851.4	6.65	[.000]
X_{it}^{RW}	0.5925	0.0638	9.49	[.000]
Std. error of regression	10727	**Adjusted R-squared**		0.247
F-test	86.1	**Durbin–Watson**		0.471
Normality test χ^2	0.176	**Observations**		261

6.7 Industrial Balances of Trade with the EU

The specification of the model to test the evolution of the Czech trade balance in an industrial breakdown with the EU is as follows:

$$X_{it}^{EU} - M_{it}^{EU} = \Phi_B \, (GDP_t^{CZ}, \; GDP_t^{EU}, \; RER_t, \; PC_{it}, \; PM_{it}, \; PX_{it}, \; K_{it}/L_{it}, \; FDI_{it}, \; Tar_{it}^{CZ}, \; Tar_{it}^{EU}, \varepsilon_{it}) \quad (9)$$

Since we get a negative trade balance for approximately half the industries, which precludes logarithmic transformation, we divide the data into two subsets: one for positive balances and one for negative balances.

For policy-making purposes, we are thus able to distinguish between policies supporting a positive balance and policies supporting domestic import substitution. The separated equations also offer an interesting description of the factors underlying the Czech revealed inter-industrial comparative advantages (in Tables 10a and 10b) and comparative disadvantages (in Table 10c).

The first experiments with the linear model show that nearly all of our explanatory variables are statistically significant. However, only two variables (FDI and *K/L* endowments) are statistically significant after logarithmic transformation, as Table 10b indicates.

Our comments will be on the comparison of all three Tables 10a, 10b and 10c. FDI with a positive sign is a feature common to all of them. This confirms our previous observations that during the past nine years FDI was not a clear contributor to the trade surplus. Its heavy dependence on imports reveals that Czech domestic production was not very competitive in providing the necessary material inputs, which must have been imported. FDI was attracted primarily by low-wage Czech labour inputs, the comparative advantage of which can be exploited in non-automated assembly operations. The ability of Czech net exporters (and especially large net exporters) to challenge the RER appreciation is again made apparent in Table 10a. However, the existence of a positive coefficient between RER and net exports should be interpreted as a reversed causal link (i.e., the RER as a function of successful export performance) rather than being viewed according to the more conventional interpretation where RER is the exogenous cause.

Table 10a: Balance of trade with the EU – surpluses only, linear specification
      (dependent variable:(X-M))

Variables	Estimated parameters	Standard Error	t-statistics	P-value
Intercept	44457.800	19319.600	2.301	[.023]
M price/kg	-15.635	6.390	-2.447	[.016]
X price/kg	19.056	6.887	2.767	[.007]
Price changes	-20971.400	9313.500	-2.252	[.026]
FDI stock	**0.484**	**0.109**	**4.443**	**[.000]**
Tariffs CZ	-453.766	145.191	-3.125	[.002]
K/L ratio	**-1287.940**	**204.341**	**-6.303**	**[.000]**
RER to euro	314.746	137.118	2.295	[.023]
Std. error of regression	5969	Adjusted R-squared		0.545
F-test	23.4	Durbin–Watson		--- [21]
White heterosc. test	110.3	Observations		132

Table 10b: Balance of trade with the EU – surpluses only, logarithmic specification
      (dependent variable: ln(X-M))

Variables (logs)	Estimated parameters	Standard Error	t-statistics	P-value
Intercept	3.290	0.077	42.839	[.000]
FDI stock	0.180	0.028	6.480	[.000]
K/L ratio	-0.575	0.107	-5.390	[.000]
Std. error of regression	0.479	Adjusted R-squared		0.247
F-test	22.5	Durbin–Watson		--- [21]
White heterosc. test	7.44	Observations		132

Table 10c: Balance of trade with the EU – deficits only, logarithmic specification
      (dependent variable: ln(X-M))

Variables (logs)	Coefficients	Standard Error	t-statistics	P-value
Intercept	29.919	4.245	7.048	[.000]
M price/kg	**0.961**	**0.268**	**3.590**	**[.000]**
X price/kg	-0.522	0.266	-1.962	[.052]
Inflation	-3.053	1.040	-2.936	[.004]
FDI stock	**0.186**	**0.044**	**4.239**	**[.000]**
Tariffs CZ	**-13.846**	**2.128**	**-6.508**	**[.000]**
K/L ratio	0.551	0.309	1.783	[.077]
Std. error of regression	0.446	Adjusted R-squared		0.426
F-test	16.6	Durbin–Watson		--- [21]
White heterosc. test	65.3	Observation		129

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[21] *The D–W statistics have lost their meaning, since the 1993–2001 time series sequence was in some cases impaired by the splitting of data from the same industry into two subgroups.*

There is much space left for improving the Czech trade balance if domestic import substitution in material inputs is successful. Policies for promoting backward spillovers from FDI enterprises could be instrumental in this important strategic change.

Another important common feature is the finding that pressures for upward price adjustments are present both in industries with low net exports and low net imports, and in industries with a very low level of trading. The former are generally industries with large intra-industrial trade. It is known that such industries are subject to oligopolistic competition, dominance by multi-national capital and market power.

The sectoral "inflation" is then either created internally as rent, or it is imported from abroad – reflecting the high quality of the sector's imported products or the gains in export prices. Large price hikes in low-traded sectors imply that the dominance of non-traded commodities in these industries is prone to internally generated inflationary pressures.

The negative sign for the Czech tariffs in Table 10a indicates that only those industries originally defended at home by high tariffs are poor net exporters. The import protection of industries with comparative advantages did not require high tariffs. In contrast, Table 10c indicates that a decrease in the tariffs with the EU is an important driver of structural import penetration on the Czech market.

We should comment on the K/L ratio, which has different signs in our last two equations. This implies that the industries with comparative advantages are highly labour intensive while the net importing industries are more capital intensive. This tendency is revealed just at this stage, after we eliminated the impact of intra-industry trade from our data. We can therefore finally confirm that the paradox of the parallel labour intensity of exports and imports from the EU is eliminated if we analyse the inter-industry specialisation pattern only.

This feature, however, is not highly statistically significant, indicating that many imports (especially those in industries with incomplete intra-industrial trade) are also labour intensive. Thus, unfortunately, a policy for import substitution based on rising capital-to-labour endowments can be only partially successful – only where the capital endowment shortage is the sole engine for import penetration. Rising Czech relative capital endowments (e.g., due to high saving and investment propensities) will therefore lead to two different pressures for a fundamental restructuring:

First, a decrease in import penetration into industries prone to high inter-industry specialisation; unfortunately such industries have usually only exclusive imports (such as raw materials with a low level of domestic substitution), hence this will not change their industrial trade balance much.

Second, an increase in export capacities in capital-intensive industries, which will have a more pronounced impact on the domestic economy than in the previous case; the adjustment period can be long and it can adversely hit the labour market, where pressures for unemployment and wage stagnation can become serious.

The trade balance (X-M) can be improved by future heavy capital investments in three ways[22]:

a)   By promoting labour productivity, technical change and product quality in industries that are currently net exporters. Here we can expect that investments into human capital will be a necessary complement of physical capital build-up. This will promote export penetration;

b)   By investing disproportionally in "medium" or slightly more capital-intensive industries such that they switch from being net importers to being net exporters. It can be expected that the competitiveness of traditional net-exporting industries (which are labour intensive) will be eroded as wages rise. New replacements will be then recruited from the aforementioned "medium" industries. The global impact of this strategy would be mixed – balancing export expansion with import substitution;

c)   By investing in capital-intensive industries, which will strengthen domestic import substitution.

Our analysis also suggests that these developments can be expected to come very soon, because the present Czech openness to imports is unnaturally high and the enterprises with FDI have endowed themselves sufficiently with machinery and financial capital. It should be the right time now for domestic growth to switch from being import and labour driven to being capital driven. The induced import substitution (especially in material imports) could then become an ideal driver for future GDP growth. Taken from the point of view of the macroeconomic identity X-M=I$_f$, falling imports accompanied by steady inflows of FDI would imply that export growth could then subside – even becoming negative – while the RER can appreciate.

There could be more focus on terms-of-trade gains *via* higher unit prices and increased quality. Support for human capital development would be paramount for such a strategy. Unfortunately, a prudent wage-rise policy is also crucial in this respect. If the labour-intensive industries that are being phased out are not restrained in their wage-cost increases, the demise of these industries will merely be accelerated and the rising unemployment will be difficult to absorb in the expanding capital-dependent industries. Both unit prices in our Tables 10a and 10c are statistically significant, and they always have opposite signs. The industries subject to inter-industrial trade (i.e., those industries where the X_{it}^{EU}- M_{it}^{EU} balance is high) gained by successfully increasing their per-kilogram prices. The role of improvements in quality was therefore important to their growth on both sides of the trade balance. The negative sign for per-kilogram prices of foreign competitors to Czech exports in Table 10a, however, points to generally low levels of processing in those Czech export products.

In other words, even though Czech net exporters are not in high-value-added sectors, their improvements in the given sectors were an important part of their export expansion. A very similar trade strategy can be seen in the sectors with high net import penetration. The dominance of quality over price competitiveness is also confirmed here. Either the Czech import substitutes are of inferior quality or the imports are in material inputs that do not have a high per-kilogram price.

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[22] The Czech Republic has very high ratio of internal domestic savings to GDP. At the same time there are high inflows of FDI, and foreign credit has become quite easily available to many enterprises under foreign ownership.

7. Models of Exports and Imports with Adjustments for Estimation Problems

This part of our study deals more closely with alternatives in the methodology of estimation where we concentrate on static determining factors of industrial specialisation and suppress the importance of dynamics. Unfortunately, the specific nature of our data, where the structural dimension is enhanced by the time dimension, exposes the estimation of coefficients to a situation of several trade-offs. Corrections for gains on one side have to be compensated by losses in some other aspects of estimation. Therefore the search for the proper estimation technique could not be concluded at this experimental stage. What follows are various alternatives to the OLS estimation, none of which can be considered a clear-cut winner.

As is evident from the tests in the previous section, there are several caveats that prevent us from further commenting on our results in the first round of estimations. For example, after comparing the extremely low values of the D–W statistics in Tables 5 and 6 with their critical values, we see the presence of a strong serial correlation due to autoregressive dependence in the disturbances. At this intermediate stage of our testing, we do not find the causes for these random cyclical pressures in Czech trade with the EU. It may be a data problem, a specification problem or an estimation problem. For example, we are aware that at this stage we cannot cover the full range of theoretical specifications. We have to omit the variables of comparative advantage in relative productivity (or relative unit cost of production) and of economies to scale. Our estimation is static (based on least squares), while more modern techniques of panel data estimations use the GMM (generalised method of moments) technique that deals with dynamics.

The other problem we had concerned is heteroscedasticity, which, as indicated by the White test, was at the margin of tolerance. The reliability of the estimated t-statistics could thus be undermined because the standard errors were biased. We have therefore corrected the estimation automatically using weights related to the error term (as used in the White test). In the first step we will concentrate on the removal of serial correlation, which seems to be the most pressing problem and much more resilient to deal with.[23]

7.1 The Autoregressive Procedure in the Error Term

The easiest remedial measure for the autocorrelation of residuals is to estimate the model using the AR (autoregressive) procedure, as offered by TSP. The model of exports can then be formulated as before, with the exception of the error term. For example, the model of exports to the EU can be re-designed as:

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[23] Autocorrelation of residuals can aggravate the estimation if some important variable (e.g., a dummy) was not included in the data. The most important source of autocorrelation could be incomplete specification of the model. As was already mentioned, at this stage of the research we still lacked some theoretically important variables such as total factor productivities, wage rates and labour price/capital price ratios. Therefore, before establishing for certain that a missing explanatory variable was not our problem, and in line with the caveats given by Mizon (1995), we could not proceed too far with our remedial measures for the removal of autocorrelation. Nevertheless, our regression estimates can still be considered unbiased and still retain crucial analytical information.

$$X_{it}^{eu} = \beta_0 + \beta_1 \, ln(GDP_t^{eu}) + \beta_2 \, ln(RER_t^{eur}) + \beta_3 \, ln(PC_{it}) + \beta_4 \, ln(PX_{it}^{eu}) +$$

$$+ \, \beta_5 \, ln(PM_{it}^{eu}) + \beta_6 \, ln(K_{it}/L_{it}) + \beta_7 \, ln(FDI_{it}) + \beta_8 \, TAR_{it}^{eu}) + \rho \, \varepsilon_{i,t-1} + u_{it} \qquad (10)$$

The newly introduced parameter ρ estimates the functional dependence between the original error terms $\varepsilon_{i,t-1}$ and $\varepsilon_{i,t}$, while u_{it} is a new non-autocorrelated error term. In addition, fixed effects should be included in the estimation. We test this procedure and the autocorrelation was eliminated by obtaining a D–W test of 2.06. To our relief, we find that the list of significant variables does not change. Unfortunately, we still cannot be sure whether the autocorrelation is properly measured by the D–W statistics (see footnote 20). A full list of results (estimated on a differently structured data set) is presented in Benacek and Visek (2002).

7.2 Estimation by Generalised Least Squares

Once we have estimated ρ using the procedure above, we can proceed by using Cochrane–Orcutt transformation of data (see Judge *et al.* (1985, p. 286), or Kmenta (1986, p. 303). For example, a transformed variable of exports (X^*_{it}) should be created using the formula: $X^*_{it} = ln \, (X_{it}) - \rho * ln \, (X_{i,t-1})$. After a similar transformation is applied to all the remaining variables, a new linear model can be estimated using a procedure known as generalised least squares.

We test a similar procedure proposed by Durbin (see Judge *et al.* (1985, p. 287) on a slightly modified model where the lagged variables (marked as "back shift" B) were separated and estimated together with the original variables. The results are shown in Table 11, where the only statistically significant variables were those with a lag.

Table 11: Exports to the EU after Cochrane–Orcutt transformation
        (dependent variable: ln X_{it}^{EU})

Variables (logs)	Estimated coefficient	Standard error	t-statistics	P-value
Intercept	0.505	0.240	2.099	[.037]
Ln(B-X)	0.963	0.026	37.591	[.000]
Ln(B-PX)	0.038	0.010	3.937	[.000]
Ln(B-PC)	-0.257	0.112	-2.289	[.023]
Ln(B-FDI)	0.017	0.008	2.245	[.026]
Std. error of regression	0.230	**Adjusted R-squared**		0.967
F-test	1719.6	**Durbin–Watson**		1.846
White heterosc. test	56.5	**Observations**		232

Although from the technical point of view the estimation becomes perfect, there are three problems that should be noted:

a)   The lagged endogenous variable (exports in this case) becomes strongly significant that it eliminates from the model many other economically important variables; for example, we lose the variables of K/L, tariffs and GDP, which become "locked in" to the lagged export variable;

b) The model may be infested with too many lagged variables (some of them in addition to the non-lagged variables), whose economic interpretation is difficult;

c) Actually, the whole original economic (theoretical) specification is significantly altered; we largely lose the ability to test the hypotheses of structural significance while gaining on predictive capacities, which are not our explicit task at this stage. Therefore, we do not proceed further with this method of estimation.[24]

7.3 Estimation with Fixed Effects by Industries

It is a characteristic feature of the panel data (provided there are sufficient degrees of freedom in the time series) that we can estimate how the characteristics of the individual industries differ from the common characteristics estimated using standard methods giving just one intercept common to all industries. The unique slope can then be broken down into individual (partial) intercepts based on the time series only. The statistical characteristics of the estimation may thus be largely modified. The problem is explained in Figure 3, where the pool of data is split into subpopulations that are time-series specific for each industry. The industrial subpopulations are fitted with upward-sloping lines reflecting their common time-dependent behavioural characteristics.

Unfortunately, the explanatory characteristics of the general features in such a model can decline sharply if the industries are highly heterogeneous and their behaviour is too autonomous. It must also be stressed that the fixed effects of individual industries fundamentally change the hypothesis tested, because the estimation switches from the primarily structural (cross-sectional) explanation of trade to trends in time-dependent characteristics of variables. This means that the estimations in section 6 addressed the determining factors of specialisation, while the estimations in this section are more suitable for the analysis of overall dynamics and forecasting.

7.3.1 Imports from the EU

The statistical characteristics of the estimation of fixed effects by industries in imports from the EU are given in Table 12.

Table 12: Model of imports from the EU estimated with fixed effects by industries (dependent variable: ln M_{it}^{EU})

Variables (logs)	Estimated parameters	Standard Error	t-statistics	P-value
GDP ^{CZ}	3.865	1.031	3.747	0.000
RER ^{EUR}	1.938	0.576	3.366	0.001
Std. error of regression	1.94	Adjusted R-squared		0.932
Normality test χ^2	0.127	Observations		261

[24] For the same reason we do not proceed further with using first differences of all the variables as a remedy for the autocorrelation. It is true that if the D–W statistic is quite close to zero, we may infer that parameter ρ should be close to unity. In that case, the taking of first differences of our variables can lead to the best linear unbiased estimator of the coefficients (with no constant term). However, the conditions for such a correction are quite strict – see Mizon (1995). At this provisional stage we cannot risk experimenting further with this technique, which, among other drawbacks, significantly modifies the economic content of the tested hypotheses.

Unlike the fixed effects of time, the fixed effects by industries are all statistically significant at the 1% level. Their effects are so strong that they overrule all variables with structural information by industry. This signals that the existing structural characteristics remained unchanged in time – which is information of great explanatory significance. On the side of imports and their structure, the Czech economy is strongly dependent on the initial pattern of specialisation, which is invariant over time.

After we eliminate the statistically insignificant variables, we are left with all 29 fixed effects and with two variables with an exclusive time dimension: GDP and RER. The average elasticity of imports to changes in GDP^{CZ} over time is 3.86, while at the same time the elasticity to RER appreciation is 1.93. The combined explanation offers the following outcome: both the domestic GDP growth and the appreciation of the koruna's RER dramatically boost the absorption capacity of imports that is at the same time slowed down by structural rigidities in industries. The weight of these rigidities is captured by the negative coefficients of fixed effects with values from -42 through -50. The high overall growth is, however, spread irregularly among industries, as is explained by the model discussed in Table 5.

As a policy implication, the freezing of the GDP in the recent past is the most efficient instrument for curbing the growth of Czech imports. Viewed in the opposite direction, any overheating of the Czech economy would be accompanied by sharply rising imports. The real appreciation of the exchange rate is also an important factor, though weaker in its elasticities than the GDP.

The potential for new imports created by aggregate demand and RER appreciation (as described in Table 12) has to be allocated into imports of concrete industries. This is never done in a perfectly proportional way because there are factors determining the non-uniform pattern of specialisation. The allocative mechanism dealing with structural factors (looking backward in time) is explained in Table 5. The leading role is given to the FDI inflows and to the competitive edge given by products with high value-added contents. The dismantling of Czech tariffs seems (from the point of view explained in Table 12) to be more a passive (*ex post*) allocative operation – not a primary causal factor of global import penetration.

7.3.2 Exports to the EU

Exports to the EU estimated using fixed effects by industries reveal the more sophisticated nature of the export dynamics (see Table 13). The evolution of the aggregate demand (GDP) in the EU is their most important determining factor of growth. In addition, the growth is accelerated by rising per-kilogram prices. We can interpret this phenomenon as an impact of improved quality and/or gains in goodwill. As shown in Table 4, this positive impact on export growth is very strong throughout 1995–2001. For example, in 2000 it contributed to an overall growth of exports to the EU by 5.5%, that is, by a quarter.

In addition to the previous two factors, there is a positive influence from the regular decrease in the EU tariffs and the build-up of capital per worker. Therefore, it is not surprising that in the environment of four strong drivers of export growth, the expected negative impact of the RER appreciation on exports is found to be statistically insignificant by the model.

Table 13: Model of exports to the EU estimated with fixed effects by industries
         (dependent variable: ln X_{it}^{EU})

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
X price/kg	0.262	.038	6.90	.000
Tariffs [EU]	-1.523	.293	-4.20	.000
K/L ratio	0.236	.087	4.99	.000
GDP [EU]	2.748	.203	13.54	.000
Std. error of regression	0.332	**Adjusted R-squared**		0.935
Normality test χ^2	0.094	**Observations**		261

In comparison with Table 6a, in Table 13 we can see that the lists of explanatory variables remains unchanged (with the exception of FDI). Note that export unit prices and the K/L requirements reverse their signs. As far as the former is concerned, it is evident that the initial downward-sloping distribution of export intensities in industries relative to prices (where the highest volume of trade is concentrated in commodities with lower per-kilogram prices) received a shock as the restructuring of the Czech economy progressed. The largest export gains during 1993–2001 are in those industries where the quality gains were the highest. If such a trend is to continue for long, the perverse structural specialisation of Czech exports might be reversed. This is a highly positive and new finding of this research.

A similar trend is observed in the changing sensitivity of exports to capital per labour and tariffs. In the former, the build-up of endowments of capital per labour pushes exports up. An important question remains: were the investments in capital spread evenly among all industries, or are they eventually biased towards labour or towards capital-intensive industries? The latter would imply a destabilisation of the present structure of specialisation and a need for the gradual reallocation of labour to different industries. According to the Rybczynski effect (see Brenton et al. (1997, pp. 93-109)), that would not proceed without structural unemployment, stagnating wages and the need for skills restructuring and migration.

The dismantling of the EU tariffs boosts the total trade by giving more chances to industries with initial high barriers. The "true" elasticity of exports to the changes of GDP in the EU is revealed only in Table 13, because the similar variable in Table 6 measures only the accelerating structural changes in exports subject to the changes in aggregate demand, after the effects specific to time are eliminated by dummies for fixed effects of individual years.

Finally, we touch on the question of the role of FDI in Czech exports to the EU. As a comparison of the results in Table 13 with Table 6 connotes, FDI is not an inherent cause of trade creation. The potential created by factors in Table 13 is actually utilised by FDI for a concrete structural expansion subject to comparative or competitive advantages. A close relationship can be sought between FDI and two variables at its service: PX or K/L improvements. Thus, the FDI can be presented in Table 13 only indirectly.

The RER variable was rejected by the model as a factor of trade dynamics. In the Czech case, the RER against euro was steadily appreciating and thus slowing down exports. Nevertheless, the

export price gains, the falling institutional barriers to trade and gains to productivity coming from the FDI and build-up of physical capital could diminish the negative role of RER appreciation to a statistical insignificance.

7.3.3 Imports from the Non-EU Countries

The results from the estimation of coefficients of this model are shown in Table 14. All 29 fixed effects by industries are statistically significant and negative. The real exchange rate of the dollar (appreciating since 1996) is identified as the dominant source of import penetration. The elasticity of non-EU imports to Czech aggregate demand is much lower than that of imports from the EU. The role of FDI is auxiliary, exerting only a mild pressure on import penetration. The rising unit prices for import dynamics and their structural penetration is again stressed. Tariffs and K/L requirements are not considered as factors causing the trade creation, even though they were crucial for allocating imports among industries (as described in Table 7).

Table 14: Model of imports from the non-EU countries estimated with fixed effects by industries *(dependent variable: ln M_{it}^{RW})*

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
M price/kg	0.264	0.078	3.36	0.001
FDI	0.050	0.017	2.88	0.004
GDP ^{CZ}	1.565	0.619	2.53	0.012
RER ^{USD}	2.828	0.497	5.68	0.000
Std. error of regression	0.313	Adjusted R-squared		0.957
Normality test χ^2	0.077	Observations		261

7.3.4 Exports to the Non-EU Countries

The estimation of this model is technically the most controversial, and its coefficients should be viewed with caution. First, the fixed effects by industries have low statistical significance and become volatile as we delete the insignificant variables and dummies from regressions. Second, the normality test χ^2 in Table 15 warns of the possibility that we may estimate only the second-best results and that a different coefficient could be generated if the model is estimated in an alternative way.

Table 15: Model of exports to the non-EU countries estimated with fixed effects by industries *(dependent variable: ln X_{it}^{RW})*

Variables (logs)	Estimated parameters	Standard Error	t-statistics	P-value
X price/kg	0.221	0.053	4.184	0.000
K/L ratio	-0.518	0.087	-5.941	0.000
GDP ^{RW}	6.071	1.516	4.004	0.000
RER ^{USD}	-5.057	2.122	-2.383	0.018
Std. error of regression	0.257	Adjusted R-squared		0.966
Normality test χ^2	0.003	Observations		261

The most striking feature is the extremely high dependency of exports on both GDP and RER. In addition, the K/L variable has a negative sign. One possible interpretation is that exports are not determined primarily by investments in physical capital, but by falling employment in leading export industries. Such intensive restructuring could bring the K/L ratio down while the competitiveness of products could rise, thus increasing exports.

7.4 Estimation by Robust Statistics

Some of our previous problems could have their origin in faulty data or the reporting methodology. For example, some of the data could be contaminated by random mistakes (e.g., typos in changing tonnes for kilograms in trade quantities) or by systematic differences in the methods of reporting in individual years (see Section 4). As a result, the data could be polluted by outliers that may seriously bias the estimation.

A more complicated problem may arise when the panel data set does not behave in a homogenous way across years or across industries. We test the former contingency by pooling the data sets into the years 1993–1996 and 1997–2001. We do not find large behavioural differences between them.

In contrast, we find that some industry segments (e.g., mining and primary processing) behave differently from the others. Our experience from previous analyses (Benacek and Visek (1999), (2002)) show that some industries lagging behind in their intensity of restructuring behave in an opaque way – actually contradicting the theoretically assumed patterns. For example, a declining industry in distress could be very export oriented, even though it lacks comparative advantage. Exports "financed" by implicit subsidies or by running debts could be a temporary solution concealing the real status of the industry.

Some complicated robust statistics are designed especially for testing which subpopulations of the data behave differently from the "normal" sample (see Visek (1996), (2000)). As an illustration, let us consider the model in Table 6b, based originally on 261 observations (i.e., 29 industries and 9 years for each of the 9 variables):

$$\ln(X_{it}^{EU}) = 19.32 - 0.073 * \ln(PX_{it}) + 0.267 * \ln(FDI_{it}) -$$

$$- 4.409 * \ln(TAR_{it}^{EU}) - 0.930 * \ln(K_{it} / L_{it}) + 1.059 * \ln(GDP_{it}^{eu}) + \varepsilon_{it} \qquad (11)$$

By applying the method of *least trimmed squares (LTS),* we can test for the occurrence of "weird" observations and uncover the degree to which they behave in opposition to the pattern estimated in the original model. We are then looking for an estimation of $\hat{\beta}^{(LTS,n,h)}$, which minimises the sum of the *h* smallest squares of the residuals *r* :

$$\hat{\beta}^{(LTS,n,h)} = \arg \min_{\beta \in R^p} \sum_{i=1}^{h} r_{(i)}^2 (\beta), \qquad (12)$$

where $\beta \in R^p$ and R^p is a *p*-dimensional Euclidean space, that is, β is a p-dimensional vector.

The problem is then estimated from

$$r_i^2(\beta) = \{ \ \log(X_{it}) - \beta_0 + \beta_1 * \log(PX_{it}) - \beta_2 * \log(FDI_{it}) +$$

$$+ \beta_3 * \log(TAR_{it}^{eu}) + \beta_4 * \log(K_{it}/L_{it}) - \beta_5 * \log(GDP_{it}^{eu}) + \varepsilon_{it} \ \}^2 \tag{13}$$

The statistics considered in the sum given by (12) are defined for each $\beta \in R^p$ as

$$r_{(1)}^2(\beta) \le r_{(2)}^2(\beta) \le \ldots \le r_{(n)}^2(\beta). \tag{14}$$

By trial and error, we can choose the following sequence of estimations for h = 261, 250, 240, 230, 220 and 210, obtaining an estimation of the variances of the error terms and the coefficients of determination for the re-estimated whole equation (see Table 16).

Table 16: The dependence of variances $\hat{\sigma}^2$ and R^2 on the number of observations h

h	261	250	240	230	220	210
$\hat{\sigma}^2$	0.638	0.471	0.385	0.326	0.279	0.240
R^2	0.629	0.706	0.741	0.773	0.804	0.832

The estimated coefficients of our model then change as shown in Table 17.

Table 17: Sensitivity of coefficients to the deletion of some contradictory observations
         (dependent variable: ln X_{it}^{EU})

h	261	250	240	230	220	210
Intercept	19.32	14.74	15.01	15.64	17.67	21.32
Ln(PX)	-0.073	-0.129	-0.125	-0.158	-0.171	-0.171
Ln(FDI)	0.267	0.266	0.257	0.253	0.265	0.272
Ln(TAR)	-4.409	-4.359	-4.360	-4.507	-4.785	-4.759
Ln(KL)	-0.930	-0.923	-0.917	-0.941	-0.946	-1.004
Ln(GDP^EU)	1.059	1.583	1.553	1.579	1.493	1.064

In Table 18, we list the excluded "weirdly behaving" observations.

From this table, we can gather that (with just one exception) the subpopulations of the data excluded by the individual steps h are "nested" – that is, they are subsets in the data sequence of the previous subsets. The exclusions thus have a certain regularity that is industry specific. Once the industry behaves differently from what the model generally suggests, it tends to behave so during all the observed years.

After deleting just 11 observations, we also find that the estimated coefficients suddenly become more stable, which implies that the core of the data set is homogenous (see Table 17). It is free of solitary ("spurious") outliers contaminating the data and causing serious bias in the coefficients.

Table 18: List of excluded observations by individual steps h *(the number of all the observations used in each of the five steps is indicated in the first column)*

All obser-vations	Excluded observations (by their original sequenced numbering)													
250	25	26						38	39		41	42	43	44
240	25	26	27					38	39		41	42	43	44
230	17	18	25	26	27		37	38	39	40	41	42	43	44
220	17	18	25	26	27	35	37	38	39	40	41	42	43	44
210	17	18	25	26	27		37	38	39	40	41	42	43	44
250	45						62	63						
240	45						62	63			109	110		
230	45					59	62	63			109	110		
220	45		51	52	58	59	62	63		90	109	110	111	113
210	45	50	51	52	58	59	62	63	89	90	109	110	111	113
250														
240		118		128	129									
230		118	127	128	129									
220	114	118	127	128	129	156								
210	114	118	127	128	129	130	131	132	133	134	135	156	161	162
250														
240							222	223	224	225				
230		178	179	180		221	222	223	224	225				
220	177	178	179	180		221	222	223	224	225				
210	177	178	179	180	189	221	222	223	224	225				

For example, in the first exclusion step (for *h*=250) there are 11 excluded points (out of a total of 261) flagged as "irregular". Apart from four other points (25, 26, 62 and 63), there are also 38, 39, 41, 42, 43, 44 and 45. These actually constitute nearly the whole industry of "mining of non-energy-producing raw materials", representing exports of sand, stones and kaolin. This is a negligible export industry (with prohibitive transport costs), with the exception of high exports in 1993 and 1996, which are the only non-deleted observations. After deleting this single (practically non-tradable) industry from the data set, we get the results shown in Table 19.

Table 19: Robust estimation of Czech exports to the EU
(mining of non-energy-producing raw materials excluded, dependent variable: ln X_{it}^{EU})

Variables (logs)	Estimated parameters	Standard error	t-statistics	P-value
Intercept	18.959	4.429	4.28	[.000]
X price/kg	-0.160	0.025	-6.28	[.000]
FDI stock	0.279	0.018	15.61	[.000]
Tariffs EU	-4.469	0.353	-12.65	[.000]
K/L ratio	-0.979	0.062	-15.69	[.000]
GDP EU	1.172	0.428	2.74	[.007]
Std. error of regression	0.716	**Adjusted R-squared**		0.688
Normality test χ^2	0.129	**Durbin–Watson**		0.576
White heterosc. test	70.3	**Observations**		252

An improvement in all the tests (compared with Table 6a) is already evident in the first step of the analysis. The most significant change occurs in the income and export price coefficients, which gain in both magnitude and significance. This gives us an important new conclusion: the dependence of the structure of exports on both aggregate demand and price concessions might be higher than previously estimated if we drop from the analysis observations contradicting the behavioural patterns valid for the main body of economic agents. At the same time, the remaining three basic variables retain their stability.

By proceeding with our pooling, we can separate a whole subset of industries whose behaviour contradicts the behaviour patterns of the majority of Czech export-oriented industries. Further analysis of these industries may be instrumental in uncovering the trends behind declining industries, as well as emerging trends that will be important for the changing structure of the balance of trade in the future. The analysis of "normally" and "weirdly" behaving industries by means of the robust technique would gain in economic meaning if we could apply the technique to data at a more disaggregated industry breakdown.

8. Conclusions

We shed new light on trade dynamics by explaining it in terms of income and real exchange rate movements in a way, which the conventional analyses of the Balassa–Samuelson effect or real exchange rates are not able to capture. In addition, our approaches to testing the determining factors of Czech trade balance offer some new insights, based on the role of supply-side characteristics (factor endowments, FDI, competitiveness) – see the summary of main empirical findings below. The accord of our empirical conclusions with economic theory and economic fundamentals is an advantage, as regards the credibility of policy decision-making.

It seems that both the extraordinary growth of Czech trade creation and its intensive structural transformation follow certain microeconomic theoretical paths more closely than was presumed. The essence of the factors underlying the Czech pattern of specialisation and the GDP growth rests in the dynamics and proportions of factor inputs, which makes them dependent on constraints in relative factor endowments. It is highly evident from our tests that the future of the Czech trade balance and the GDP growth will hinge on the way how the Czech economy substitutes its present comparative advantage in labour by building up its capital endowments, and most notably its human capital endowments.

Although our tests confirm that the balance of Czech trade is deeply influenced by the exchange rate, aggregate demand and tariff changes (especially in the short run), the underlying fundamental factors for keeping the trade balance in equilibrium rest on supply-side characteristics, which are closely related to the export and import structural and efficiency adjustments.

Now, in a period of economic structural stabilisation and EU accession, the prospects for accelerated economic growth led by quality improvements in exports and domestic import substitution are much higher. It also seems to us that industrial policies (such as support for FDI, capital availability, the build-up of human capital, labour mobility, and the promotion of domestic

import substitution) can lead to highly significant changes in the nature of Czech external economic relations and international competitiveness.

Experiments with alternative specifications of the basic model show that our results can potentially be used for medium-term predictions of trade balances and simulations of various policy scenarios. Nevertheless, the present research has not yet been concluded in the above sense and further experiments are expected.

Our empirical analysis leads to the following main findings:

1. In analysing trade patterns, we must distinguish between factors behind the dynamics of trade creation and factors behind the structural allocation of trade in industries. The latter describe the mechanics of how the *status quo* of specialisation was determined in the past, while the former point to forces for a change (or stabilisation) of the *status quo*. In the interpretation of model results we have to distinguish between the structural (static) and the time (dynamic) aspects of trade, where the current state of specialisation and the forces of growth pose a different economic explanation of events. In the methodology of estimation we have to experiment with fixed effects of time and fixed effects by industries.

2. The main drivers of the Czech international trade dynamics are associated with changes in the relevant aggregate demand (GDP) and the real exchange rate. Reduced growth of the Czech economy after 1996 is an important factor that keeps the balance of trade at a sustainable level in the medium-term, contributing even to the appreciation of the real exchange rate.

3. Two additional factors influencing the trade dynamics are highly significant: changes in endowments of physical and human capital, and the nature of Czech economic competitiveness *vis-à-vis* the world markets. The last of these includes the switching from competition in prices to competition in quality, and the rising role of differentiated products and intra-industry trade. At the same time, there are also the positive effects of dismantled trade barriers (tariffs), inflows of FDI and exceptionally fast switchover in Czech exports towards products with higher unit prices.

4. Appreciation of the real exchange rate is a handicap to Czech exports, especially to exports to the non-EU countries. Nevertheless, in the EU case, the appreciation has been countervailed by tariff concessions, improved quality, switchover to commodities with higher contents of value added, gains associated with FDI and growing foreign demand absorption.

5. Appreciation of the real exchange rate has significantly opened the Czech market to imports but the unconstrained import penetration remained blocked by the growing competitiveness of Czech products (competing in costs, prices and quality). The threat of widening trade balance disequilibrium has been neutralised also by rising export prices while their physical volumes stagnated.

6. The fundamental restructuring of Czech enterprises is driven by openness to trade, especially with the EU. While exports based on comparative advantages and the inflow of FDI offer growth and employment, accelerating import penetration requires the downsizing of many industries and the closing down of many enterprises. In the analysed period of 1993-2001 the

structural adjustments burdened the Czech economy with high costs. The overall GDP growth thus could not be very high.

7. The dynamics of Czech exports and imports remain "locked-in" within certain structural constraints that can be changed only gradually. There is still present the legacy of specialisation in products at a low level of value added (i.e., in products with low per-kilogram prices) and of competition based on price concessions and on massive inputs of labour with low-wage requirements.

8. The "nominal convergence" of domestic prices in industries is only very loosely associated with comparative advantages. However, price concessions made by enterprises to gain competitiveness in Czech exports have a measurable impact on trade intensities, though their role is only subsidiary.

9. The dismantling of the EU tariffs on Czech exports had an important role in opening trade potential to Czech enterprises. In contrast, Czech tariff concessions to imports from the EU were less important in opening the Czech economy to EU competition. Tariffs on trade with non-EU countries have a significant regulatory role in shaping the structural allocation of trade with these economies.

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